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NOTES ON TREE DISEASES
IN
WESTERN EUROPE, 1950

by

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INTRODUCTION

During the past 25 years, four trips have been made to western Europe to study forest tree diseases, particularly those caused by pathogens and occurring on North American tree species which have been so widely introduced there. The first visit from May to October, 1925, was largely spent in Great Britain just at the time the extensive reforestation program was getting underway, although brief trips were made to Denmark and France (Boyce 1925, 1926, 1927). The second visit from July to September, 1935, was again spent in Great Britain largely on the Dutch elm disease caused by Ceratostomella ulmi although a little time was given to other diseases (Boyce 1936). The period from February through August, 1939, was mostly spent in Germany, with some travel in the Netherlands, Switzerland, Denmark and Sweden (Boyce 1939, 1940b, 1941). During the last trip from February to July, 1950, France, northern Italy, western Austria, southern Germany, Switzerland, Holland, Belgium, England and Wales were visited.

With each trip the value of the observations previously made has been considerably enhanced, particularly when localities have been visited for the second or even the third time. Furthermore, over such a long period it has been possible to follow the changing status of certain diseases both in their actual development and in their evaluation by forest pathologists and foresters. The following notes are largely a record of the observations made during 1950 with the interpretation often modified by information obtained in previous years. Help was given by and information obtained from so many colleagues that it is not feasible to make individual acknowledgments. However, the Index of Persons lists the many individuals who aided either directly or indirectly. In every country visited the writer met with courtesy and fine cooperation.

In the following pages names followed by dates, i.e., Badoux (1932) or (Badoux 1932), are references to publications listed under "References," whereas names alone, i.e., "according to Pavari" or "(Pavari)" are to be found in the "Index of Persons." In the longer sections general statements and conclusions are at the beginning of the section followed by the detailed field notes.

ARBORETA

Although there are many arboreta in western Europe, only a few were visited since larger plantings were of more value for observations on tree diseases.

At Vallombrosa, near Florence, Italy, the Stazione Sperimentale di Selvicoltura has a field station and some of the instruction is given there to students from the School of Forestry in the University at Florence, the only forestry school of university rank in Italy. The arboretum at Vallombrosa contains 3000 species of trees and shrubs. The oldest trees are single individuals 65 years old. A new portion of the arboretum, established in 1922, is composed of group or block plantings.

The arboretum of the École National des Eaux et Forêts, Nancy France, was established in 1901, in the nearby Forêt d'Amance and covers 40 hectares. The elevation is 750 feet and the annual precipitation averages from 27.5 to 31.5 inches. The soil is good on the whole, although somewhat clayey; better adapted for broadleaf trees than for conifers, the ground originally having been occupied by Fagus sylvatica, Carpinus betulus, Quercus robur, Acer campestris, and Populus tremula. The trees in the arboretum are in small groups of 15 to 20. In addition around Etang de Brin there are larger plantations of exotics, the oldest of which were established nearly 50 years ago. Many American species are represented in both localities.

The arboretum at Les Barres, near Nogent-sur-Vernisson about 60 miles from Paris should be an extremely valuable one to examine but unfortunately it was not visited by the writer. It is under the technical direction of the École National des Eaux et Forêts, Nancy. The arboretum covers about 2000 hectares and about 1000 tree species are represented. It was established 150 years ago; certain species are now in the third generation and show that racial characteristics have remained constant. The students from the school at Nancy are trained in dendrology there.

REFORESTATION

Reforestation has been extensive in western Europe, both with exotics and with native European species outside their natural range, so there is abundant opportunity to study the effects of an unusual habitat on the reactions of various species to disease. The most extensive plantations of exotic conifers, particularly of species from the Pacific Northwest and British Columbia, are in Great Britain. The extensive

acreages in the mountains of Wales clothed with vigorous conifers, largely Pseudotsuga taxifolia and Picea sitchensis, are a most impressive sight, particularly when the same localities were visited that were seen as treeless valleys and slopes 25 years ago. Similarly, the extensive pine plantations (Pinus sylvestris and P. nigra var. calabrica) on relatively flat ground in East Anglia and from which pit props are now being removed were first seen when planting was beginning. Pacific Northwest conifers have also been extensively planted in Denmark, but this country was not visited. Several unusually interesting reforested areas were seen in various countries.

The Pinetae near Ravenna, Italy, one of which is owned by the town of Ravenna and the others by the national government, consist of Pinus pinaster close to the sea and back of that P. pinea which is less hardy against the winds from the Adriatic. The purpose of these pine forests is twofold, viz., recreation and pine nuts (pinocchi) from P. pinea. Since these pine stands are so valuable for recreation, no cutting, thinning, or other silvicultural practices, except pruning, are allowed. The stands are thin with large openings. There is an abundant understory of Quercus pedunculata. The stands were originally established by direct seeding, and this method is continued today, which accounts for the irregularity of the stands. The various stands are now 14, 27, and 70+ years old. The trees are of poor quality. The soil is very sandy. Some of the stands at from 12 to 20 years have shown decided yellowing at irregular intervals with heavy needle cast. Many trees have been removed because of this color. According to Carullo none of these diseased trees were present at the time of my visit. Did see some yellowed 14-year-old trees. The yellowing suggested nitrogen deficiency, a likely difficulty in such sandy soil. Pinus pinea is not native to the Adriatic side of Italy and Ravenna is as far north as it will grow. Fomes annosus occasionally is damaging which is to be expected in this type of stand. Lophodermium pinastri was prevalent on dead needles of both species of pines but as a saprophyte. Fomes pini seen once fruiting at pruned branches at 6 feet and 8 feet above ground on an 80-year-old tree, D.B.H. 22.0 inches.

On Mt. Cimone, near Sestola, Italy, extending from about 3500 to 6000 feet, reforestation (or afforestation) has been underway since 1905. The land was formerly poor grazing land, devoid of trees, with erosion beginning. Now about 3000 acres have been planted, and cutting in the oldest stands will begin within a few years. Sestola has become a fine summer resort, just because of this forest, which is

owned by the town but the work directed by and most of the cost paid by the national government. Abies pectinata comprises 80 per cent of the plantings. Pinus nigra f. austriaca is planted where erosion is worst. Some Picea excelsa used at the higher elevations. A little Larix europaea and Cedrus deodara also seen. There were three small plantations of Pseudotsuga taxifolia, Chamaecyparis lawsoniana, and Thuja plicata which had grown very well. A little Scotch pine has been planted.

With the exception of a little Rehmiellopsis bohemica of no consequence on A. pectinata, not a single pathogen was seen on any species. According to the foresters in charge, this forest is extremely healthy, but it is much younger than the forest of Vallombrosa.

That a native species outside its natural range horizontally or vertically may be just as vulnerable to disease as an exotic is illustrated by Abies pectinata at Vallombrosa, Italy. The forest of Vallombrosa comprises about 3000 acres and goes back to 800 A.D. It was controlled by the Benedictine monks until some time in the nineteenth century (1887?). Originally the forest was composed of Fagus sylvatica and Abies pectinata at the higher elevations with Quercus, mostly Q. cerris, as an understory, and with Castanea sativa occupying the lower levels. Because of a strong demand for Abies pectinata, the mixed stand was converted to pure silver fir which is the basis of the forest today. In addition fir has been established below its lower altitudinal limit. The fir is of exceptionally fine quality which together with the proximity to Florence (40 kilometres) enables it to command an unusually high price. However, as a pure even-aged stand on land which it did not originally completely occupy, Abies pectinata, particularly at the lower elevations, is subject to considerable killing by Armillaria mellea following drought years. Butt rot caused by Fomes annosus is rather prevalent, and an occasional tree has a cankerous burl on the trunk caused by Melampsorella caryophyllacearum (M. elatina). According to Pavari these are the only three diseases of any consequence in the forest.

Between St. Etienne and Bourg-Aregental in France at a high elevation is an extensive forest of Picea excelsa of various ages with a little Abies pectinata originally established by planting. Some of the spruce was being cut; trees up to 16 inches D.B.H. This would be an excellent forest to study the diseases of a native tree established outside its natural range.

Near Genck in northern Belgium afforestation is underway on a large expanse of flat land, with a poor sandy and rocky soil.

The land is first shallow ploughed, then disc-harrowed. Pinus sylvestris and P. nigra austriaca seed is sown in circular areas, the space between the circles is sown principally to Quercus borealis with some Sorbus, Alnus, and other broadleaves. Seed sown by scattering and brushed into loose soil with branches. Acorns sown in fall, seed of conifers and other broadleaf trees in the spring. Broadleaf trees occupy 26 per cent of the space. Sowing much cheaper than planting which was done on these lands before the last war but is now too expensive. Sowing began in 1948 and there has been a good catch of seedlings.

Near Heywich, Belgium, Pinus sylvestris and P. nigra var. calabrica were planted mostly pure, but in some instances mixed with Larix leptolepis, in 1926, 1928, and 1929 on poor, sandy, rocky soil much the same as that near Genck. P. sylvestris is extremely poor; slow growth and crooked stems. The Corsican pine has done much better, giving a satisfactory yield. However, in the winters of 1939-40 and 1941-42 it was injured by cold followed by an attack of Brunchorstia destruens (Crumenula abietina), but evidences of the disease have disappeared. P. sylvestris was not affected.

The forests of the city of Lausanne, Switzerland, comprise about 4000 acres which have been under the management of professional foresters for approximately 100 years. Annual precipitation averages from 40 to 50 inches, the elevation ranges from 1830 to 3170 feet, and the natural forest is largely mixed hardwoods, with some Abies pectinata and a little Picea excelsa at the higher elevations. There are two major divisions of the forests, Vernand-dessous and Gisiaux. From about 1890 to 1898, Inspecteur Forestier Curchod-Verdeil established small plantations of exotics, mostly conifers from the Pacific Coast. The development of these and other exotics in Switzerland have been described by Badoux (1932). The unsatisfactory result of changing natural stands of mixed hardwoods and conifers in this forest to pure stands of conifers are discussed under Fomes Root and Butt Rot.

By contrast to conditions in stands of unnatural composition particularly if monocultures of exotics or of native trees outside their natural range, are conditions in the Austrian Tirol. According to Rieder the forests of the Tirol are 96 per cent conifers and 4 per cent hardwoods with Fagus sylvatica composing most of the latter. Picea excelsa comprises 68 per cent of the conifers, the remainder being Larix decidua, Abies pectinata, Pinus cembra (valuable for furnature), P. sylvestris (called Weisskiefer to distinguish it from Schwarzkiefer = P. nigra austriaca). There is little Scotch pine and no Austrian or black pine in the Tirol. More broadleaf trees would improve

the forest soil and Fagus sylvatica is being mixed with conifers wherever possible. There are almost no exotics in the Tirol forests, only specimen trees as ornamentals and a few small experimental plantations. Native species, largely naturally reproduced are depended upon. Planting is resorted to when natural reproduction fails. Seed from native trees is used, none of it is imported, and the seed is collected from mother trees in the same general locality where the nursery stock is to be planted out. It is a fixed policy not to use exotics and not to change natural stand composition, although over a long period there has been an increase in conifers at the expense of hardwoods.

The forests are unusually healthy, and this was noticed by an American forester who visited the Tirol in the past year. Larch canker is unknown. No diseases of any importance on spruce. Fomes annosus is relatively rare. Scotch pine occasionally has a harmless needle rust, but no Kienzopf (P. pini) and no schütte (L. pinastri). Little heart rot in any species; when found usually a butt rot.

That Tirolean forests are healthy was confirmed by the examination of stands at Hungerburg and Igls near Innsbruck, in the vicinity of Kitzbühel, and on the Austrian side of the Brenner Pass.

Around Igls, elevation 3000 feet, the stands are coniferous consisting mostly of Picea excelsa, with some Larix europaea, and an occasional Pinus sylvestris; ratio possibly 90:9:1. The only hardwood was Betula verrucosa with a few scattered trees of small size and extremely poor form. The coniferous stands are approximately even-aged, they are clear cut in blocks or sometimes strips, natural reproduction by seed from the surrounding stand is depended upon, and the adjacent stands are not cut until the reproduction is established. In some areas Larix europaea is left standing after the spruce is cut until the reproduction of spruce and larch is well established.

The stands in the vicinity of Igls were largely free from pathogens. Found nothing on Scotch pine except a relatively innocuous needle fungus, which looked something like Hypodermella concolor on lodgepole pine in the United States, but immature. One larch showed a largely healed trunk lesion which might have been canker. A little brown butt rot in a few felled trees. Spruce showed no conks of Fomes annosus but the decay was occasional in the butts of felled trees, although the total cull was slight. An occasional sapling had needles browned by Lophodermium macrosporum, but no damage.

In the region around Kitzbühel there was an epidemic of Lophodermium piceae (L. abietis) on Picea excelsa in the late summer of 1949 according to Obergmeiner. Defoliation was so

severe that some trees died. However, when the stands were seen in the spring of 1950 it seemed evident that the epidemic had subsided. An occasional spruce had butt rot caused by Fomes annosus but loss from this fungus on the whole was insignificant. Galls caused by Melampsorella elatina were common on branches of Abies pectinata, but galls on the trunks were rare. No other diseases were seen.

NURSERIES

In the province of Pistoia, about 20 miles northwest of Florence, 90 per cent of ornamental shrub and tree, shade tree, and forest tree nurseries in Italy are located.

The firm of Arturo Ansaloni is 25 years old and now has 200 acres of nurseries in 7 areas all within the vicinity of Bologna. A nursery is also maintained near Rome for distribution purposes. Ornamental trees and shrubs, shade trees, fruit trees and forest trees are raised, and the company deals extensively in tree seeds. Five retail stores are maintained. The main nursery at Bologna and the one at Monghidoro were visited, the latter being 45 kilometres from Bologna on the road to Florence near the Raticosa pass, elevation 2700 feet.

A windbreak (one row) of Pseudotsuga taxifolia, 15 years old, 12 to 20 feet high was free of disease. Ten-year-old Picea pungens was only 12 to 18 inches high. A few Thuja plicata disease free. Chamaecyparis lawsoniana growing vigorously but one-sided because of the wind. Libocedrus decurrens was disease free, but had grown slowly. Juniperus virginiana was without any disease (no Phomopsis juniperovora or Gymnosporangium spp.) either at Monghidoro or at the main nursery at Bologna. A few Pinus strobus seen but no Cronartium ribicola.

RACES OF TREES

The many arboreta and plantations in western Europe are excellent places to see clearly how common and important races are within various tree species. Unfortunately, for many exotics and even for native species, although racial differences are so evident, it is often impossible to determine their significance because the provenance of seed from which the trees originated is usually unknown. However, group plantings of various races of Pinus sylvestris in several countries are old enough so that reasonably reliable conclusions can be drawn. Plantations of Pseudotsuga taxifolia to test seed provenance have been established in Germany, Netherlands, France, and Great Britain. Such plantings are also to be found in Denmark.

According to Pavari the most reliable visible character for the identification of species, varieties, strains, and races of trees is the bark which is most constant in character, whereas foliage is extremely variable. This is particularly true with exotics.

A large scale test of races of Abies pectinata is underway at Vallombrosa, the trees now being 15 years old. The best race so far is the one from Vallombrosa. Pavari expects to publish the results of this investigation soon.

The different races of Larix europaea can be distinguished by the character of their cones, according to Rubner, but this criterion is only about 90 per cent effective.

EXOTIC TREES

Exotic trees have been widely introduced into Europe beginning in the eighteenth century. Because of the few native species of value on that continent and of their relatively slow growth the search has been for faster growing species and those that might have technical qualities not found in the indigenous trees. Conifers are needed most so they have been distributed in far greater numbers representing more species than hardwoods.

In any examination of exotics in Europe two factors are striking, viz., the difficulty of proper site selection and the frequent lack of knowledge of the provenance of seed. The first largely accounts for conflicting reports regarding the behavior of introduced trees and the second often makes it impossible to reach exact conclusions not only about exotics but also about European trees established outside their natural range.

Conifers

The most extensively introduced conifers in western Europe are Douglas fir (Pseudotsuga taxifolia), Sitka spruce (Picea sitchensis) and Japanese larch (Larix leptolepis). Lowland white fir (Abies grandis) is now being favored because of its rapidity of growth and freedom from disease so far, whereas Douglas fir and Sitka spruce are no longer regarded with unqualified optimism because of attacks by disease and insects. The finest exotic in Europe would have been eastern white pine (Pinus strobus) but its usefulness has been largely destroyed by Cronartium ribicola, although there are many localities where this valuable tree could still be grown successfully.

The most extensive plantations of Douglas fir and Sitka spruce are in Great Britain and Denmark. Douglas fir has also been widely

established in Germany where exotics have been planted so commonly in the past. However, in that country there is much less planting of exotics now because seed is too expensive. In southern Germany the two potentially most promising introduced conifers are now considered to be Abies grandis and Larix leptolepis. In Switzerland exotics have been experimented with limitedly, Douglas fir being most commonly planted. The results of the older plantings have been discussed by Badoux (1932).

In the Austrian Tyrol there are only a few small plantations of exotics, Austrian foresters not having favored exotics because they are so difficult to establish. At Salzburg, Douglas fir has been planted in the Hallem, Aussee and Radstadt districts, and in the last named Picea sitchensis, Thuja plicata, and Abies nordmanniana are also to be found. There are also a few small plantations in the vicinity of Kitzbühel including Pseudotsuga taxifolia, Larix leptolepis, and Pinus strobus. Most of these have been disappointing. Exotics have been introduced to a greater extent in Upper Austria, now in the Russian zone, and considerable trouble with diseases is said to have developed. Information on the plantations of exotics including provenance of seed in the Tyrol can be obtained from the Forstmeister, Forstverwaltung Brandenberg, Kramsach, Tyrol, Austria, and for exotics for all of Austria including the Tyrol from the Forstliche Bundes-Versuchsanstalt, Mariabrunn bei Wien, Austria.

The three most important American species for Italy are Pinus contorta in the Appenine Mountains, Pseudotsuga taxifolia in the central Appenines and Pinus (insignis) radiata in the south according to Pavari who has a thorough knowledge of introduced trees in Italy. P. radiata, however, is severely attacked by tent caterpillar (Evetria sp.). Two of the best introductions for ornamental purposes have been Cupressus arizonica and Cedrus atlantica in the opinion of Alfredo Ansaloni.

Cedars

The tree of this group that has been most widely experimented with in western Europe is Chamaecyparis lawsoniana, Port Orford cedar. In general, although it has not been affected by disease, this tree is not promising because it grows slowly. The limited range occupied by this species in its native habitat shows that it is relatively exacting in its site requirements, and its requirements can probably be met rarely in western Europe. The trees in a 50-year-old plantation of C. lawsoniana in the Forst Freising, Freising near Munich were only one-fourth the height of immediately adjacent coast Pseudotsuga taxifolia of the same age.

Chamaecyparis lawsoniana planted in 1891 in Vernand-dessous, Lausanne, Switzerland, has grown slowly although no pathogens were found. However, the soil was formerly occupied by hardwoods and the elevation is higher than this species is accustomed to. In the arboretum at Nancy, 10 trees 50 years old and 20 trees 40 years old, together with some saplings naturally reproduced, were free from disease but had grown slowly. A plantation 50± years old at Etang de Brin, Forêt d'Amance, near Nancy was healthy and of good form, but growth had been slow on the heavy clay soil. A plantation 20 years old, about 15 feet high, had made slow growth, but it was disease-free in Zwolse Bos, near Zwolle, Netherlands. In Abbotswood, Forest of Dean, Gloucester, England, C. lawsoniana planted in 1904 was largely windthrown during the last war. A few scattered trees were left standing which has resulted in an extraordinarily thick stand of natural seedlings. A plantation of C. lawsoniana at an elevation of 3600 feet in the Staatsforst Kitzbühel, near Kitzbühel, Austria, has made mediocre growth (Obergmeiner), probably because of the short growing season and low temperatures at this altitude.

There was only one small tree left of a plantation of Chamaecyparis nootkatensis established about 50 years ago at the Etang de Brin, Forêt d'Amance, Nancy. This species was not suited to the clay soil.

Thuja plicata, 20 years old, although on a clay soil was vigorous, healthy, and had attained an average height of 20 feet at Etang de Brin, Forêt d'Amance, Nancy. A small plantation, now 35 years old, on a moist deep soil has grown extremely well at Vallombrosa, Italy, where most sites would be too dry for this species. No Keithia thujina present at either place.

Two groups of Libocedrus decurrens, one 16 and the other 50 years old, were healthy and had made moderate growth; better than Chamaecyparis lawsoniana in the arboretum at Nancy.

Cryptomeria japonica planted in 1891 has made the poorest growth of all the exotics in the forest Vernand-dessous, Lausanne. The tree has grown slower than Abies pectinata and Picea excelsa.

Douglas Fir

In western Europe races of Douglas fir are highly important because of their marked differences in rate of growth and reaction to disease. Although some authorities consider Douglas fir in North America to comprise two or more species, long familiarity with the tree in its native habitat leads to the conclusion that it is one species, Pseudotsuga taxifolia, but an extremely variable one in which three growth forms or races can be recoghized, namely,

(1) coast, (2) intermediate, and (3) Rocky Mountain Douglas fir. Other common names applied to these three forms are (1) green or Pacific Coast, (2) gray, Fraser River, transition or intermountain, and (3) blue or Colorado. They can be considered varieties under the names P. taxifolia v. viridis, v. caesia, and v. glauca. The coast and Rocky Mountain forms are reasonably distinct but the intermediate form, as indicated by its name, shows all gradations between the two. Peace (1948) based on his extended tour in western United States and Canada considers Douglas fir to be one species with the aforementioned growth forms.

Coast Douglas fir is important for Europe. On suitable sites it will double the volume increment of its closest native competitors, Picea excelsa or Abies pectinata. It is also beginning to reproduce naturally here and there which is promising. However, it is attacked by an aphid Adelges cooleyi which now seems to be doing much less damage than was feared when the insect was first noticed more than 25 years ago. Adelopus needle cast which has appeared more recently is now raising doubt as to the future of coast Douglas fir. This disease is discussed in detail in another section.

Rocky Mountain Douglas fir has no foreseeable value in Europe. It grows slowly so that it has no advantage over native conifers on the same sites. Furthermore, it is so severely affected by Rhabdocline needle cast that in time it will be completely eliminated. Intermediate Douglas fir might be of value in certain localities but it will be a difficult task to secure the proper strains of seed. In addition this form is also affected by Rhabdocline needle cast although less severely.

Douglas fir from 25 to 65 years old is to be found in the forest at Vallombrosa, Italy, where there are considerable plantations of it. Pavari is most enthusiastic about this tree because it produces twice as much wood volume at a given age as Abies pectinata and is so far free from any pathogen. No Rhabdocline or Adelopus needle cast has been found in Italy probably because the long, dry summer (June-October) is unfavorable to the pathogens. The best Douglas fir is from the Oregon-California region, viz., the Siskiyou Mountains. This race is highly drought resistant which is important for Italy.

Coast Pseudotsuga taxifolia 5 years old (3 years nursery, 2 years field) was 1 to 1.5 feet high in May 1950 and free from any disease, although both Adelopus gäumanni and Rhabdocline pseudotsugae occur on other Douglas fir in the locality. Possibly the proper conditions for infection by A. gäumanni have not occurred. Since the plantation of 1.5 hectares

occupies a broadleaf site several cleanings of the coppice will be necessary (Forêt d'Amance, Nancy).

Coast Pseudotsuga taxifolia 50 years old has made good growth in the arboretum at Nancy. There were no indications of any damage by Adelopus gäumanni. There was natural reproduction up to about 10 years old from these trees also without any injury by A. gäumanni. Scattered through the arboretum were Rocky Mountain P. taxifolia also 50 years old but much less than half the height of the coast form. These trees were free from Rhabdocline pseudotsugae and practically free from Adelopus gäumanni, possibly because they had passed the age of high susceptibility when these two pathogens appeared in the arboretum.

In High Meadow Beat, Forest of Dean, Gloucester, England, there are a number of provenances of P. taxifolia from British Columbia, ranging from the coast to Revelstoke, the collections having been arranged by Peace during his trip in 1938. There is one provenance from Colorado. The trees were planted out in 1942, and will be extremely valuable for contrasting the rate of growth and reaction to pathogens of various races of P. taxifolia.

Along the road to Pass Thurn, 16 kilometers south of Kitzbühel, Austria, and 1 kilometer north of the top of the Pass, elevation 1100 meters, is a mixed plantation of Pseudotsuga taxifolia and Picea excelsa, 12.5 acres in extent. 2616 Douglas firs of the coast form were set out in 1903 (now 47 years old) and in 1933 there were 804 remaining. The mortality since has been heavy, particularly in 1948 and 1949, which Forstmeister Obergmeiner attributes to the winter of 1947-48 when there were periods of warm weather, followed by intense cold, intermittently throughout the winter. This weakened the trees so that Armillaria mellea attacked them. Over the years Douglas fir has made mediocre growth, being no larger than the Norway spruce mixed with it; Douglas fir 8-12 in. D.B.H., Norway spruce 8-12 in. Infection by Adelopus gäumanni was not sufficiently severe to account for the slow growth of the trees.

Firs

Abies grandis, lowland white fir, is now being most favorably regarded by many foresters because of its rapidity of growth and freedom from disease so far. It is thought that it can ultimately take the place it was first hoped that Pseudotsuga taxifolia would occupy and next Picea sitchensis, neither of which are fulfilling their original promise because of attacks by fungi and insects. According to Peace, A. grandis will grow more rapidly in Great Britain than any other conifer. However, unless the site has a mean annual precipitation of 50

inches or more, growth declines at about the age of 50 years and the trees are no longer vigorous, although so far no definite disease has developed. Of course since A. grandis occurs over such a wide range of temperature and precipitation in its native habitat and there are climatic races within the species (Müller 1938), it would be possible to find a race adapted to drier conditions, but such a race would probably grow slowly enough so that it would have no advantage over native European conifers. The Abies grandis seen in Europe was all of the fast growing coast form.

In Abbotswood, Forest of Dean, Gloucester, England, A. grandis, 20 to 25 years old, had made excellent growth and was free from any disease.

Abies grandis plantations covering 10 hectares were made with 4-year-old stock in 1947 and in the autumn of 1950 in the Forêt d'Amance near Nancy. The trees were doing well but since the ground is a natural broadleaf site, two or three cleanings of the broadleaf coppice will be necessary to prevent suppression of the fir. A few trees have been killed by mice and a few twigs by what appeared to be insect injury similar to the twig killing on Abies balsamea by Monochamus marmoratus in New England. No Adelopus nudus on the dead needles.

Abies grandis at Étang de Brin in the Forêt d'Amance had made extremely good growth, as good as Pseudotsuga taxifolia. The trees were 47 years old and 100 feet high. They had not been adversely affected by the recent dry years culminating in 1949. There was some natural reproduction from these mother trees. Immediately adjacent A. nobilis and A. concolor 50± years old, although thrifty and free from disease, had attained a height of only 60 feet. There was some natural reproduction of both species. A. concolor had numerous frost cracks in the trunks which is a common defect of this species in France.

Abies grandis, known as Vancouver fir, seed provenance unknown, planted in 1894 in Vernand-dessous, Lausanne, Switzerland, after having made excellent growth began dying in 1945 and indications are that within a few years all or practically all the trees will be gone. Dying begins in the lower branches and extends upwards until the entire crown dies, often within a few weeks. Barbey thinks that basically the cause is drought, the tree being accustomed on the Pacific Coast to 2 to 3 times the annual precipitation that it normally gets in Bernand-dessous. Precipitation in this forest averages 40 to 50 inches annually. In addition for the last 7 to 8 years there has been a yearly moisture deficit of as high as 30 per cent in

some years. Tree is reproducing well so it will be continued since it has attained merchantable size before its decline. Barbey also thinks A. grandis should be tried on wet soils. Now on a rather heavy soil. A Belgian forester who visited this forest in 1949 said that the tree behaved exactly the same way in Belgium.

One of the Abies grandis which was dying was felled and the roots excavated. All the roots were affected by Armillaria mellea, fan-shaped mycelium being prevalent between the bark and the wood, and occasionally subcortical rhizomorphs. Wood not yet decayed beyond the incipient stage, although black lines had formed limitedly in the wood. Mycelium between bark and wood extended up the bole for 2 to 3 feet. All the roots were dead. Death of the crown occurs rather rapidly (a few days to a week or so) after the first dying lower branches are noticed, but probably it takes months to a year or more after infection occurs before the entire root system is involved and the tree finally girdled at the root collar.

In the same locality (Vernand-dessous) there were 9 trees, which have been considered to be Abies grandis, although they looked somewhat different. One of these was dying and was felled. Proved to be A. nobilis, 47 years old. No cones present although one of the foresters stated that the cones are twice the size of those on A. grandis. There are now 8 trees left. The entire root system of the dying tree had been attacked by Armillaria mellea, with mycelial fans and some rhizomorphs between the bark and the wood, but the sapwood was not yet noticeably decayed.

Abies nobilis, 50 years old, had been badly damaged by shell fire in the last war. There were also a few young trees, 3 to 12 feet high which were probably naturally reproduced. The trees of all ages were disease-free and had made good growth (Arboretum, Nancy).

A stand of Abies pectinata 25 to 30 years old in the Forst Freising, Freising near Munich, was so severely attacked by Dreyfusia nüsslini as to be practically worthless. The trees, about 12 to 15 feet high were barely growing, the needles were short, thick and yellow-green in color, and the internodes were short and thick. In this stand two dead suppressed trees were noticed with cankers on the main stem caused by Aleurodiscus amorphus, the same type of cankers as in the United States. By contrast, two stands of Abies nordmanniana, 35 to 40 years and 50 years old, had made good growth and were free from D. nüsslini. Usually this fir is heavily infested.

There are 11 species of Abies growing in the experimental forest at Grafrath near Munich. A. nordmanniana is so severely attacked by Dreyfusia nüsslini that the tree is of no value because of its slow growth. A. homolepis (Japan) grows moderately well. One tree had a witches broom and small burl on the trunk caused by Melampsorella caryophyllacearum. Abies grandis plantations, 12 and 30 years old, had grown rapidly. The trees were vigorous and free from all pathogens. The oldest A. grandis was 41 years old. A. grandis is by far the best of the Abies at Grafrath, producing three times greater volume in a given time than A. pectinata.

Larches

Larix leptolepis, Japanese larch, promises to be a valuable tree in many localities because it grows more rapidly than L. decidua and is completely free from canker caused by Dasyscypha willkommii. It is particularly favored in Bavaria where Rubner is a strong advocate of this tree. The only disease seen on it was Phomopsis canker discussed in another section. Although L. leptolepis in northern Germany has suffered from drought (Boyce 1939:40) it has not been affected by the recent dry seasons in southern Germany. Since Larix decidua has been so commonly established outside its natural range and thus is essentially an exotic in so many places, L. leptolepis should be the better tree for the future in such situations. However, it has not been successful in all situations.

In the Forst Ebersberger at Anzing near Munich, elevation 1700 feet, Larix leptolepis is doing very well, not having been affected by the dry years and being completely free from canker caused by Dasyscypha willkommii. Saw several stands of various ages. In one stand of mixed L. leptolepis and L. decidua, 45 years old, the European larch was much smaller and considerably cankered. Japanese larch also reproducing naturally. According to a Japanese forester who visited the forest several years ago the Japanese larch is doing better than in Japan where it is not considered to be a good tree.

Both L. leptolepis and L. decidua are represented in the experimental forest at Grafrath, near Munich, sometimes in mixture. L. leptolepis had grown more rapidly and was free from canker caused by Dasyscypha willkommii.

Excellent 55-year-old Larix leptolepis and very good 60-year-old Pseudotsuga taxifolia, coast form, was growing in the Forst Tübingen, Württemberg, in the area occupied by various exotics, formerly controlled by the Forstliche Hochschule of Tübingen University.

Plantings of Larix leptolepis of various ages from 15 up to 58 years old, the oldest stand in Bavaria, occur in various places in the Forst Freising, Freising near Munich. The trees have grown splendidly, do not have a single canker caused by Dasyscypha willkommii and have not been injured by the recent dry years. L. decidua in this forest is cankered.

L. leptolepis in the Staatsforst Kitzbühel, Kitzbühel, Austria has not been successful, the trees having made mediocre growth and being extremely limby (Obergmeiner).

Larix leptolepis has not succeeded in the Forst Zofingen, Zofingen, Switzerland. The plantations grew well for about 50 years and then growth declined to almost nothing. On the other hand, Larix decidua (presumably an alpine race) is doing well and continues to put on increment. No canker caused by Dasyscypha willkommii occurs on either species.

Larix leptolepis, 49 years old and 65 feet high at Étang de Brin, Forêt d'Amance, near Nancy, was free from canker or other disease. The trees grew rapidly at first but then slowed down markedly. As a comparison these trees were immediately adjacent to 47-year-old Abies grandis with a height of 100 feet.

The only Larix occidentalis seen was in the arboretum, Nancy, France. The trees were 14 years old, growth had been moderate, and they were free from any disease.

Pines

Among the conifers from North America introduced into Europe, pines have played a minor role compared to representatives of other genera, particularly those from the Pacific Coast, although the exotic first planted on a relatively large scale was Pinus strobus. At present no American pines are planted except for a little P. strobus here and there, and plantations of P. (insignis) radiata in southern Italy and Spain which were not seen. A number of fungi have been reported on this tree in Spain (Martínez 1942).

The best tree ever introduced into western Europe in the opinion of this writer was Pinus strobus, eastern white pine. It has flourished on a wide range of soils from pure peat to extremely sandy, and under widely varying climatic conditions. It is not doing well on heavy clay soils. The wood commands a higher price than any other conifer native or introduced; in Switzerland, for example, from 2 to 4 times the price of Picea excelsa. It is most unfortunate that its usefulness is so circumscribed by Cronartium ribicola. However, since wild Ribes are so limited in western Europe there are places without them and sufficiently removed from farm gardens containing the ubiquitous and deadly Ribes nigrum

where Pinus strobus could be grown safely and profitably. Cronartium ribicola is discussed in another section.

Pinus strobus 47 years old, although of good form had made mediocre growth because of the heavy clay soil at Étang de Brin, Forêt d'Amance, near Nancy. The trees were free from blister rust because there are no Ribes in the forest and none in farm gardens sufficiently near to cause damage.

A plantation of Pinus strobus, 18 years old and about 10 acres in extent on Kaiser Gebirge, near Kitzbühel, Austria, is said to be growing vigorously and is free from Cronartium ribicola (Obergmeiner).

Pinus ponderosa planted 50 years ago at Étang de Brin, Forêt d'Amance, near Nancy, had all disappeared, apparently because they were not suited to the heavy clay soil.

A splendid specimen tree of Pinus ponderosa, fast growing and of fine form, about 50 years old, was seen in the arboretum at Vallombrosa, Italy. There was also a good specimen of P. lambertiana, 65 years old, very large but limby. Both trees have done so well as to suggest that they may be suited to the dry climate of the Appenines, similar to the Sierra Nevada of California.

There was a stand of Pinus contorta, 16 years old, immediately adjacent to P. sylvestris of the same age in the Forst Ebersberger at Anzing, near Munich, elevation 1700 feet. Although P. contorta was free from disease it had not grown nearly so well as P. sylvestris. However, P.contorta had grown faster the first few years.

Spruces

Of the spruces introduced into western Europe, Picea sitchensis is the most promising, but because Sitka spruce is exacting in its site requirements and is being severely attacked by an aphid, Elatobium (Aphis) abietinum, and a bark beetle, Dendroctonus micans, the species is no longer so highly regarded as it was 10 to 20 years ago or more when it was thought the tree might supplant Pseudotsuga taxifolia. Too often it has been planted on an unsuitable soil, where the annual precipitation is too low, where temperatures are too severe or where some other adverse factor is operative. Unless sites are properly selected, this tree may be unnecessarily discredited. Unfortunately the ill effects of an unsuitable site usually do not show up until some years after a stand has been established.

Picea sitchensis on the whole is better adapted to Great Britain, where the climate is nearer that of its native habitat,

than to most of continental Europe. Even so, care must be exercised in selecting the areas where it is to be established. Neither the aphid, Elatobium abietinum, nor the bark beetle, Dendroctonus micans, have been found on P. sitchensis in Great Britain. A fine, healthy, vigorous stand was seen in the Coed-Y-Brenin Forest, Hengwirt Beat (Division) near Dolgelly, Wales, at an elevation of 800 feet.

In the Forest of Dean, Gloucester, England, P. sitchensis planted in 1924 was noticed dying in 1947. The dead trees formed an approximate circle, but when the stand was seen in June, 1950, there was little or no further dying. No pathogen has been connected with the dying trees, but it was noticed that some of the living, though not vigorous individuals, had a dead main root as seen near the root collar, similar to drought-affected P. excelsa in northern Bavaria. The stand is situated on shallow rootable soil at an elevation of 800 feet, and where the mean annual precipitation is 35 inches. In its native habitat, P. sitchensis is accustomed to a deep soil and precipitation of at least double this amount. The cause of this dying is probably an unsuitable site for P. sitchensis on which it is adversely affected during periods when conditions become critical, subnormal moisture for example, or even that the site under normal conditions is unable to support the trees when they attain the age at which they make the greatest demands on the soil, usually from 25 or 30 years up to 50 years for most species.

In the Netherlands, according to Voûte, P. sitchensis is attacked by Dendroctonus micans when the trees attain an age of 45 to 50 years so that it now seems doubtful that the species can be grown beyond that age. P. excelsa, the original host for the beetle, is not significantly infested in the Netherlands, but it has been damaged in the Harz Mountains in Germany and severely attacked in Belgium. The first severe damage to P. sitchensis in the Netherlands began in 1935 (Boyce 1939:46).

Picea sitchensis planted in the Forst Rapperswil, Rapperswil, Switzerland, has failed even on deep moist soils. The growth was good at first, then the trees became moribund and died at about 25 years of age for no apparent reason (Nüesch). P. pungens behaved in the same way.

Picea sitchensis also failed in the Forst Zofingen, Switzerland. For the first 30 to 40 years growth was satisfactory but then increment practically ceased and the trees died.

In Vernand-dessous, Lausanne, P. sitchensis planted in 1898 has made only fair growth so far and increment is falling off more and more. The tree is undoubtedly on an unsuitable site. The altitude is too high and the soil is adapted for broadleaf trees which formerly occupied the area. A dying tree was felled.

Armillaria mellea was present in all the roots and for 1 to 2 feet up the butt between bark and wood.

Picea sitchensis, 32 years old, planted on turf was free from any disease. The trees had grown rapidly at first, then the growth rate declined so that the stand was growing slowly. (Forst Baindt, Baindt near Ravensburg, Württemberg, elevation 1800 feet.)

Picea sitchensis, 48 years old, had made slow growth and most of the trees had died although no pathogen was present. However, the mortality could be attributed to a heavy clay soil the effects of which were accentuated in the last few years by drought (Étang de Brin, Forêt d'Amance, Nancy).

A plantation of 1200 Picea sitchensis established in 1902 at an altitude of 4900 feet in the Staatsforst Kitzbühel, Kitzbühel, Austria, was reduced to 181 trees by 1933 and to 132 by 1949 (Obergmeiner). The remaining trees are irregular in form and have grown slowly, apparently because of the short growing season and cold weather at this elevation.

Picea engelmanni and P. pungens 15 to 25 years old in the arboretum at Nancy had most of the 1949 needles browned on every twig, although occasional individual needles among the brown were completely green. Needles of all the older internodes were normal green. The disorder appeared during the late winter so it is probably winter drying, although the presence of unaffected needles among the brown is difficult to explain. An occasional yellowed or browned needle seemed to have tiny, black fructifications just beginning development in the stomata (Rhizosphaera kalkhoffii?).

Miscellaneous Conifers

A group of Sequoia gigantea planted in the forest Vernand-dessous, Lausanne, about 1894 has made fair growth but there was no reason to expect the tree to become of any forest value. No pathogen seen. It was also planted in mixture with Fagus sylvatica at the same time. S. gigantea has grown more slowly in mixture than pure, but in mixture it had pruned better and the branches were smaller. No pathogen seen. A few trees 50 years old and some younger ones were disease free in the arboretum at Nancy, but had made only moderate growth. In the experimental forest at Grafrath near Munich, only two or three slow growing specimens of S. gigantea were left, the others having all been killed by severe cold in the winter of 1929.

Tsuga heterophylla, 14 and 50 years old, had made moderate growth in the arboretum at Nancy. Several of the older trees had died from the drought of 1949 and previous years. Not far

away at Étang de Brin, 50-year-old trees although free from disease had made extremely slow growth in the heavy clay soil. These trees were shown as T. mertensiana on the plantation map but were actually T. heterophylla.

There were various other exotics in the experimental forest, at Grafrath near Munich, but no pathogens were found on any of them. Chamaecyparis lawsoniana, Thuja plicata, Pinus contorta, Abies nobilis, and Tsuga canadensis all have made slow growth. Tsuga heterophylla has grown well but not in comparison to coast Pseudotsuga taxifolia and to Abies grandis.

In Abbotswood, Forest of Dean, Gloucester, England, Tsuga heterophylla, Thuja plicata, Pseudotsuga taxifolia, and Picea sitchensis were planted in mixture in groups of sixteen. At first the rate of growth was in the order listed, Tsuga heterophylla growing most rapidly. The order is still the same, but the growth rate of T. plicata is declining, whereas that of P. taxifolia and P. sitchensis is increasing.

Hardwoods

The exotic broadleaf species most widely distributed in western Europe is Quercus borealis, because it has developed better than any other introduced hardwood that might serve the same purpose. It is the most valuable hardwood introduced into Italy according to Pavari. Small plantations up to 50 years old are to be found in various countries, whereas individuals, groups, or rows of shade and ornamental trees are even older. Red oak is so far free from any damaging disease. The pathogens on it are of scientific interest but not of economic importance. Near Tübingen, Germany, a Nectria canker was seen on a single tree, but this is an unusual occurrence. Recently there has been a report of a canker disease in southwest France which probably was Nectria (Moreau 1950). A canker on the trunk of a living tree caused by Stereum rugosum was sent from the Schwarzwald to Schlenker at Stuttgart. Although canker on oaks caused by this fungus is known in Europe (Bergenthal 1933; Liese 1930) its occurrence on Q. borealis is evidently unusual. In Switzerland and Belgium it has been found that ring shake develops frequently in trees at about the age of 40 years. Furthermore the tree is not favored in Switzerland because it is a highly intolerant species and in addition nothing valuable will grow under it.

A plantation of Q. borealis, 25 to 30 years old, in the Forst Freising, Freising near Munich, was free from disease and had made good growth. In the Commune Möhringen, Forst Hohenheim, Württemberg, there were a small number of planted Q. borealis and considerable nursery stock. Growth of both satisfactory; no disease. In the Forst Tübingen, close to Tübingen, Württemberg, there was a good 50-year-old stand of Quercus

borealis. One tree, 15.0 inches D.B.H. had a canker on the main stem at 12.0 feet above ground level caused by Nectria galligena. In the same locality Carya sp. and Fraxinus americana are established (same age as oak). Permanent sample plots in all three species. These plantations were originally owned by the Forstliche Hochschule of Tübingen University but the school was moved to Freiburg in 1920. Lorey worked with and reported on these plantations.

Two small groups of Quercus borealis were examined in the Forst Langenthal, Langenthal, Switzerland. One group was composed of trees 45 to 50 years old, 6 to 12 inches diameter breast high and 40 to 45 feet tall; the trees of the other group were younger. The trees of both groups had made satisfactory growth and were free from disease.

Quercus borealis, planted in 1892 in Vernand-dessous, Lausanne, Switzerland, has grown twice as rapidly (increment) as native Q. pedunculata although the quality of the wood is not as good. Excellent soil here. Seems to be a desirable tree for reforesting barren, poor soils, but not desirable on good soils because it grows too fast to produce wood of satisfactory technical quality; rings too broad for good furniture (Barbey). No pathogens on the tree, but the stand was thinned in 1938 and 1944 with an increasing amount of ring shake in the butt portion of the bole. Same thing found in Belgium. Apparently at about 40 years ring shake becomes prevalent in this species.

Quercus borealis, 51 years old, had attained a height of 60 feet on a heavy clay soil at Étang de Brin, Forêt d' Amance, near Nancy. The trees were vigorous and free from disease.

At Étang de Brin, Forêt d'Amance, near Nancy, plantations of various exotic broadleafs were established on a heavy, clay soil. Quercus palustris, 52 years old and of good form, was 35 to 40 feet high having made slow growth about comparable to native Quercus robur. Liriodendron tulipifera 50± years old was extremely small, crooked, and most of the trees had died. Carya alba and C. glabra (C. porcina), about 20 years old, although free from disease had made slow growth and were of poor form. Prunus virginia and P. serotina, about 50 years old had made extremely slow growth being only 4 to 6 inches D.B.H. and 30 feet high with crooked boles. Furthermore there were several trunk cankers at 2 to 4 feet above ground level. Although plainly of pathogenic origin the causal organism was unknown. The cankers were more irregular in outline than are Nectria cankers on P. serotina in the United States. Juglans nigra had disappeared.

Populus spp., varieties, and hybrids which have been widely introduced are discussed under Poplar Canker.

Robinia pseudoacacia has been the most valuable tree introduced into Italy from North America in the opinion of Arturo Ansaloni. It is vigorous and aggressive. It is particularly useful when planted on poor soils to check erosion. It produces small fuel wood quickly but it has never been allowed to grow large enough to furnish posts. Only a few roadside trees were seen in Italy and they were disease free. The few trees seen in France were disease free except for those attacked by mistletoe. The most extensive plantations of this species in Europe are in Hungary and Roumania.

Quercus borealis followed by Robinia pseudoacacia are the most valuable introduced broadleaf trees in Italy in the opinion of Pavari.

DROUGHT

For some time various parts of Europe have had one or more years with a precipitation deficit. In some years the deficit has been sufficient to constitute a severe drought resulting in direct injury to forest stands or weakening the trees so they succumbed to pathogens not virulent in vigorous stands. The dry years in the Netherlands were 1947, 1948 and 1949, the last named the worst. In the region around Nancy the year 1949 was exceedingly dry and several previous years had subnormal precipitation. However, there was no evidence of drought injury on any of the exotic or native trees examined in May 1950.

The dry years from 1946 to 1949 in Bavaria have been extremely destructive to conifers, particularly Picea excelsa (Woelfle 1949, 1950). Spruce to the value of several million marks was killed by bark beetles (largely Ips typographus and Pityogenes chalcographus), and by root rot fungi (Armillaria mellea and Fomes annosus) which followed the drought. Typical was a 100-year-old stand near Lichtenfels which was examined on April 23. Nearly half the stand had been removed already which was characteristic of extensive spruce stands in northern Bavaria. In addition to the dead trees with A. mellea and Ips, a number had died and were still dying which showed a main root dead close to the tree and always on the south side. All the other roots remain healthy but the tree dies. Sometimes a dead streak extends up the trunk from the affected root. These roots have not been excavated to determine whether or not the root dies from the tip up to the root collar and whether A. mellea is present lower down. However, a root of that size mechanically girdled or cut off close to the tree does not cause its death. Since the dead root is always located on the south side of the tree there may be a relation to the drastic opening up of the stand.

Other species were little affected by this drought. Larix leptolepis, which in northern Germany is considered susceptible to dry weather, was not injured.

In the forest Vernand-dessous, Lausanne, a number of exotics were planted from 1891 to 1894. Beginning about 1945, Picea sitchensis, Abies nobilis and particularly Abies grandis have been dying with Armillaria mellea abundant in the roots and butt. Apparently the moisture deficit of the last several years had weakened the trees sufficiently so that the fungus could attack them vigorously. Pseudotsuga taxifolia, Chamaecyparis lawsoniana, Sequoia gigantea, and Cryptomeria japonica had not been infected so far as known.

The attack of Armillaria mellea followed by Fomes annosus on Abies pectinata at Vallombrosa, Italy, was caused by the severe drought of 1944-1945 which seriously weakened the trees, enabling these fungi, particularly A. mellea to become pathogenic (Biraghi 1949). The last named fungus caused swelling of the base of the tree and cracking of the bark. In Biraghi's opinion these two fungi become pathogenic only when trees have been weakened by other factors. Where the trees were not affected by drought, neither fungus was pathogenic. Drought injury was severe to firs below their natural altitudinal limit. Furthermore these firs were in pure stands on ground originally occupied by mixed broadleaf trees.

LIGHTNING

In a pole stand of Pseudotsuga taxifolia and Picea excelsa in the Netherlands, two P. taxifolia were struck by lightning and died quickly, followed later by the death of several surrounding trees which showed no outward evidences of injury. This was a typical lightning spot or "Blitzlöcker" such as Tubeuf and others had described so often in German forestry literature.

FOLIAGE DISEASES

In Europe where wood values are so much greater than in North America, foliage diseases which reduce increment are of considerable importance, particularly on exotics. The latest foliage disease which appears to be serious is the spruce disease the cause of which has not yet been determined.

Adelopus Needle Cast of Douglas Fir

This disease caused by Adelopus (Phaeocryptopus) gäumanni which was first noticed in Switzerland in 1925, spread rapidly and now occurs in most of western Europe

including Great Britain and Ireland. Although the origin of the fungus is obscure it is probably native to North America from where it was introduced into Europe (Boyce 1940a).

The disease, wherever found, is strikingly inconsistent in its behavior as has been demonstrated in Great Britain (Peace 1949). There is a curious lack of relation between the apparent intensity of infection by the fungus as evidenced by the development of perithecia, and discoloration and casting of the needles. Individuals with normal green foliage and no abnormal loss of needles may be quite heavily infected according to the perithecia present, whereas other trees with the same apparent degree of infection may be quite yellowish in color and may have cast most of their needles except those of the last two seasons. Thrifty, disease-free Pseudotsuga taxifolia of all forms or races in western Europe retains its needles for from 5 to 7 years.

This inconsistent behavior, which also extends to localities, accounts to a large degree for the different opinions encountered as to the destructive effect of the disease. In Bavaria, for example, there is considerable optimism that Douglas fir can be grown in spite of the fungus but in Württemberg there is much less optimism, one Forstmeister stating that the tree was finished (kaput) in his forest. Actually, stands in Württemberg appear to be more heavily infected than in Bavaria with no obvious climatic differences between the two to explain the variation, although the diseased stands in Württemberg are said to be generally on moister sites than in Bavaria. However, the disease is much less severe in Great Britain where the climate is moister than in either German locality.

There is racial variation in the reaction of Pseudotsuga taxifolia to this pathogen. Infection is most severe on Rocky Mountain Douglas fir, less severe on the intermediate form, and least injurious to coast Douglas fir. The disease is one of younger age classes. After trees have attained the age of about 55 years they are safe from injury. Furthermore, individual resistance is extremely marked in all races of P. taxifolia. Even in stands with heavy infection where the fungus has been present for some years there are almost always single trees either completely free from infection or only lightly infected. Consequently if necessary, it may be possible in time to build up resistant Douglas fir for growing in western Europe. This possibility is under investigation.

Two stands (1/5 acre or less each) of 34-year-old coast Douglas fir in the Forst Baindt, Baindt near Ravensburg, Württemberg, elevation 1800 feet, have had all the badly infected trees removed. The resistant trees have been numbered, seed collected from each one, and the seedlings were being grown in the experimental nursery of the Württembergische Forstliche Versuchsanstalt

near Stuttgart. When the seedlings are large enough they will be artificially inoculated with Adelopus gäumanni and the promising ones planted out for test under forest conditions. Schlenker, who is conducting the experiment, hopes that the resistance which seems so evident in certain trees in infected stands is genetic.

In 1939 it was hoped that coast Douglas fir might prove strongly resistant to A. gäumanni. In that year, Liese grew seedlings in the nursery at Eberswalde near Berlin, where the fungus did not then occur, from seed collected from a stand of the coast form at nearby Chorin, and the seedlings were planted in the Forst Baindt. Of these trees, 11 years old from seed in the spring of 1950, some were practically immune, others were moderately infected, some were heavily infected and one was dead. This experiment demonstrated that resistance is not racial, but is individual, as it is against so many other fungi attacking foliage of trees.

In the Forst Ravensburg, Ravensburg, Württemberg, elevation 1900 feet, a plantation of coast Douglas fir from 50+-year-old mother trees in Holland was seen. The trees were grown for two years in a nursery in Holland and then 500 of them were shipped by Van Vloten to Ravensburg where they were planted in 1938. The trees, 14 years old from seed in the spring of 1950, were severely attacked by Adelopus. The 1949 needles had few or no perithecia, but the 1948 needles were heavy with perithecia, many of the needles were brown and some had fallen. The 1947 and older needles were all cast. Only an occasional tree was not heavily attacked and all were infected. Of the original 500 trees, a number had been killed by snow pressure. The other stands of Douglas fir in the Forst Ravensburg were not examined, since according to the foresters they presented the same picture as in the Forst Baindt.

A number of pure plantations of Pseudotsuga taxifolia were examined in the Forst Baindt. A 48-year-old stand of the coast form had somewhat thin foliage because of A. gäumanni but was making satisfactory growth. Originally the stand was 10 hectares in area, but in 1941 a bit over 6 hectares was felled because of slow growth caused by A. gäumanni. The area was replanted with Picea excelsa. A 53-year-old stand of coast Douglas fir, heavily infected in 1939 is now recovered and growing well. According to Zimmerle trees 55 years old or more are not injured by A. gäumanni, although the needles may be infected. A 43-year-old stand was heavily attacked with many trees making little or no growth, but some trees were still growing vigorously and seemed normal. On the affected trees the twigs had needles of 3 years; 1949 clean, 1948 perithecia, and 1947 perithecia with much browning, some cast. A 39-year-

old stand of coast Pseudotsuga taxifolia which was heavily infected, had made no more growth than Picea excelsa on the same ground, although normally Douglas fir will grow about twice as fast as Norway spruce. Many trees had been killed. This is the stand in which A. gäumanni was first discovered in the Forst Baindt. In the same forest, two groups of 26-year-old Douglas fir mixed with Fagus sylvatica were seen. They were about 150 feet apart. The trees of one group were little or not at all affected whereas those of the other group were all heavily attacked and had made much less growth. Barth thought that possibly the trees heavily infected were the Rocky Mountain form, although they certainly did not look like it, since even though diseased they had better form and better growth than typical Rocky Mountain Douglas fir. Possibly the intermediate form. No cones had yet developed.

In the Commune Möhringen, Forst Hohenheim, Württemberg at 1200 feet elevation, there was a stand of 18-year-old coast Douglas fir mixed with Picea excelsa. Only a few of the Douglas firs were not severely attacked by Adelopus gäumanni. The heavily infected trees were making little growth and many had been removed. Königin thinks Douglas fir is finished in Württemberg or at least in his forest. Thankful that he had planted it in mixture.

In the Commune Plieningen 15-year-old coast Douglas fir mixed with Norway spruce was heavily attacked by A. gäumanni with only an occasional vigorous tree lightly infected.

For about 10 years the planting of Douglas fir in Württemberg was given up according to Zimmerle, but it is now being planted on a small scale with stock grown from seed collected from seemingly resistant mother trees in Württemberg forests.

It is the opinion of some authorities that Adelopus gäumanni is more severe in Württemberg than in Bavaria, because there is more damp weather when the spores are being discharged in Württemberg. However, no one has determined the exact period of spore discharge.

In the Forst Ebersberger at Anzing near Munich, elevation 1700 feet, a few 45-year-old Pseudotsuga taxifolia were examined but no indications of A. gäumanni were visible from the ground.

In the various small plantations and specimen trees of Pseudotsuga taxifolia growing in the experimental forest at Grafrath near Munich, elevation 1600 feet, and varying in age from about 15 to 45 years, the only pathogens present

were Rhabdocline pseudotsugae which was insignificant, and Adelopus gäumanni and Chermes cooleyi which were common. When this experimental area was visited in 1939 it was thought that all the Douglas fir might ultimately be killed by Adelopus gäumanni, but it has developed that the fungus reduces the growth rate of the trees but does not kill them so Douglas fir can be grown successfully. The coast form is least affected, the intermediate form is moderately affected, whereas the Rocky Mountain form is severely defoliated. Other than the three mentioned no other pathogens have attacked the tree at Grafrath.

In a 50-year-old stand of coast Douglas fir of excellent growth in the Forst Freising, Freising near Munich, elevation 1500 feet, there was no Adelopus gäumanni or Rhabdocline pseudotsugae. About 1/6 acre of natural reproduction of coast Douglas fir in an opening, trees 3 to 10 feet high, had no Rhabdocline, a little Adelopus, but a heavy attack of Chermes cooleyi. A 32-year-old stand of Rocky Mountain Douglas fir was extremely severely attacked by Rhabdocline and had a very little Adelopus. Two trees were practically dead from the effect of the fungus. F. annosus has not been found on Douglas fir in this forest.

At Berchtesgaden, Germany, a single sapling of Pseudotsuga taxifolia was found in the center of the town with a slight browning of the needles caused by A. gäumanni. Only 1947 and older needles bore perithecia but most of the older needles had been cast.

Some trees in a 47-year-old stand of Douglas fir near Pass Thurn, Kitzbühel, Austria, had a yellowish to slightly brownish colored foliage with perithecia of A. gäumanni present on the needles but the infection was not heavy. Furthermore, trees with normal green color also had A. gäumanni, but the infection was much lighter. On the twigs with discolored foliage there were perithecia on 1945 to 1948 needles, but none on the 1949. No needles older than 1945 were present. The fungus had not been recorded in this section of Austria heretofore.

In the communal forest of Zug in Kirchberg near Risch, Switzerland, there was a stand of Pseudotsuga taxifolia, coast form, now 62 years old, which was seen in 1939 as a 51-year-old stand. This stand was heavily attacked by Adelopus gäumanni in 1939 leaving only needles of two years on most trees, although some individuals seemed to be highly resistant then. The trees recovered and had needles of from 4 to 5 years on the twigs, but then another heavy attack began in 1946 and was continuing when the stand was seen

again in May 1950. Again the trees have been reduced to needles of two years, except for some highly resistant individuals, so that in the past five years the stand has made only about half the usual increment.

Another nearby stand of coast Pseudotsuga taxifolia which was about 25 years old when seen in 1939 no longer exists. The trees became practically moribund because of A. gäumanni and were removed. Replaced by a mixture of Pinus sylvestris and P. strobus, 10 years old in 1950. A few P. strobus had lesions on the main stem caused by Cronartium ribicola.

A sample plot of coast Pseudotsuga taxifolia, 20 years old in 1939, in a private forest near Zug was cut that year because infection by Adelopus gäumanni was so heavy that the trees were making practically no increment.

A 50- to 70-year-old mixed stand of Picea excelsa and Pseudotsuga taxifolia was examined in the Forst Rapperswil, Rapperswil, Switzerland. Pseudotsuga taxifolia was growing only slightly faster than the Picea excelsa, the increment having dropped off sharply in the past 10 to 13 years from the effects of Adelopus gäumanni. A small area of 50-year-old coast P. taxifolia was making slow growth with only needles of two years remaining on the twigs because of attack by A. gäumanni.

In a 50-year-old stand in the Forst Zofingen, Zofingen, Switzerland, elevation 2000 feet, originally a mixture of Pseudotsuga taxifolia and Picea excelsa, the latter had died out from suppression and had been removed. About 10 per cent of the Douglas fir had been removed because of poor growth. The remainder was still putting on about twice the increment of Norway spruce of the same age despite the fact that the twigs had only 2 to 3 years needles because of Adelopus gäumanni. Volume about 2 cubic meters per tree.

Pseudotsuga taxifolia, coast form, 50 years old, was heavily attacked by Adelopus gäumanni from 1930 to about 1939 in the Forst Langenthal, Switzerland. The trees recovered and since then have made good increment.

A stand of coast Pseudotsuga taxifolia planted in 1891 in Vernand-dessous, Lausanne, was vigorous, the crowns luxuriant and the twigs bearing needles of five years. There was no evidence of Adelopus gäumanni in the stand which had been thinned at a good profit. Pseudotsuga taxifolia in this forest has made twice as much increment as Picea excelsa of the same age. However, a stand of coast Pseudotsuga taxifolia planted in 1898 in the forest Gisiaux, Lausanne, which was vigorous had had quite thin foliage at times in the past, probably because of Adelopus gäumanni (Barbey).

A mixed stand of Picea excelsa and coast Pseudotsuga taxifolia in Gisiaux (Division 20B), Lausanne, planted about 1890 was two-storied, Douglas fir having made about 2 1/2 times the increment of the spruce. There has been no evidence of any attack by Adelopus gäumanni on Douglas fir and this tree is beginning to reproduce naturally in openings so that it is planned to continue with it. The associated Picea excelsa has suffered severely from snow-break and the incidence of butt rot caused by Fomes annosus is high.

At Étang de Brin, Forêt d'Amance, near Nancy there was a stand of coast Pseudotsuga taxifolia 49 years old and about 100 feet high, which had dense crowns and dark green needles of from 5 to 7 years on the twigs. No indications of either Adelopus gäumanni or Rhabdocline pseudotsugae seen from the ground. However, from these mother trees there was some natural reproduction from 12 to 20 feet high, with light to heavy infection of A. gäumanni but no R. pseudotsugae. This stand shows that resistance is both individual and related to age.

In the arboretum at Nancy there were plots testing races and varieties of Pseudotsuga taxifolia which although young were already informative about needle casts as follows:

(1) Rehderi, 4 years nursery and 9 years field, seed source unknown (presumably southwestern United States), severely attacked by Rhabdocline pseudotsugae and Adelopus gäumanni on the same needles; only 1950 (current season) needles and 1949 needles left, all older ones cast. In this group of heavily infected trees a few were not attacked indicating individual resistance.

(2) Guinieri, 4 years nursery and 9 years field, seed from Chiricahua Mountains, New Mexico, heavily infected with R. pseudotsugae but almost no A. gäumanni present. This indicates racial resistance to the latter fungus.

(3) glauca, presumably the same age as the former, seed from New Mexico (no definite locality) was free from any needle cast indicating racial resistance. This plot was immediately adjacent to Guinieri heavily infected with R. pseudotsugae.

(4) glauca, 6 years nursery and 11 years field, seed from Colorado (no definite locality) elevation 2600-3000 meters, heavily infected by A. gäumanni, with only 1950, 1949, and part of 1948 needles remaining; not infected by R. pseudotsugae.

(5) viridis, 4 years nursery and 9 years afield, seed from Olympic National Forest, Washington (no locality), elevation 350 meters, precipitation 2500 mm., moderate infection by A. gäumanni, 1950, 1949, and 1948 needles retained, lightly infested by Chermes cooleyi, no R. pseudotsugae.

(6) viridis, 4 years nursery and 9 years field, seed from Mt. Ranier, Washington, elevation 800 meters, precipitation 1500 mm., light infection of A. gäumanni on 1948 needles and a little on older needles, none on 1949 and 1950 needles; no other pathogens present.

(7) viridis, 4 years nursery and 9 years field, 2 plots, seed from Shuswap and Ryderwood, Washington, plots were not seen--lack of time.

(8) caesia, 6 years nursery and 11 years field, seed from British Columbia (no definite locality), heavy attack by A. gäumanni; 1950 and 1949 needles intact, no perithecia; 1948 needles yellow and heavy with perithecia; all older needles cast. No Rhabdocline pseudotsugae.

It is not possible to draw final conclusions from these plots because the trees are still too young, but both racial and individual resistance to A. gäumanni and R. pseudotsugae are indicated. Furthermore, additional weight is given to the idea that the strain of R. pseudotsugae attacking green or coast Pseudotsuga taxifolia has not been introduced into Europe.

Coast Pseudotsuga taxifolia, 3 years old in the nursery, was planted in 1931 in Zwolse Bos, near Zwolle, Netherlands, but a number of plants were killed by cold so that filling in was necessary in 1932 and 1933, hence the trees were 20, 21 and 22 years old from seed, mostly the latter age, when examined. The filling in was done with mixed stock of intermediate and Rocky Mountain P. taxifolia because no coast form was available at the time. No trees were seen that looked like typical Rocky Mountain Douglas fir. Furthermore no Rhabdocline pseudotsugae was found on any of these trees, although it is present in the forest because it was found on some individuals in the 6-year-old plantation (discussed under Fomes annosus) which was said to be all coast form. This is unlikely because Rhabdocline pseudotsugae is unknown on coast Douglas fir in Europe. In the 22-year-old plantation, infection by Adelopus gäumanni varied from light to heavy. Most of the heavily infected trees had the 1949 needles green but with perithecia, and the 1948 needles yellow with abundant perithecia. All the older needles had been cast. However, even these trees were still making satisfactory growth. Van Vloten was called to examine this stand in 1946 but according to the local forester it was first observed to be unhealthy in 1940.

Adelopus gäumanni was present on Pseudotsuga taxifolia in Willems Bos near Nunspeet but its effects were not serious as yet.

A splendid stand of coast P. taxifolia, 27+ years old (planted in 1923) was seen in the Mortimer Forest, west of Leominster, Herefordshire, England. The trees were 6 to 12 inches d.b.h., 40 to 45 feet high and had a luxuriant foliage, deep green in color with needles of 5 years retained on the twigs, or occasionally needles of 6 or even 7 years. Although A. gäumanni was present on the needles, the fungus had not affected the individual needles or the trees as a whole.

In contrast to the foregoing, several stands of coast P. taxifolia planted in 1929 in the Dovey Valley Forest, near Dolgelly, Wales, showed the effects of Adelopus gäumanni. Instead of a deep green color the foliage was noticeably yellow-green. Perithecia were prevalent on 1948 and older needles, with some trees having only 1950 and 1949 needles remaining. These stands appeared to be making reasonably satisfactory growth, but it remains to be determined just what the effect has been on increment. Again individual resistance was noticeable in some trees which had normal, luxuriant deep green foliage.

A 1926 plantation of coast P. taxifolia in High Meadow Beat, Forest of Dean, had extremely thin foliage, although infection by Adelopus gäumanni was moderate. The trees were only 12 to 20 feet high. In the plantation were two trees about 30 feet high, free from A. gäumanni and with the needles retained for five years. Even this growth is not satisfactory for Great Britain. This plantation was probably of a poor race because immediately adjacent was a mixed plantation of coast P. taxifolia and Thuja plicata both having grown vigorously, the Douglas fir averaging about 40 feet in height and with the needles of five years retained on the twigs. Not a single infected tree was seen. The plantation was established in 1921. Unfortunately the provenance of seed was unknown for both these plantations.

An adjoining plantation of intermediate P. taxifolia, established in 1926, seed from Shuswap Lake, British Columbia, was free from A. gäumanni. The trees were from 20 to 30 feet high.

Rhabdocline Needle Cast of Douglas Fir

This disease, caused by Rhabdocline pseudotsugae which was introduced into Scotland from North America prior to 1914, and then spread to Germany about 1926, is now wide-

spread in western Europe, although it is not yet reported in Italy or Spain possibly because in most localities in those countries the weather is too dry for the fungus. This needle cast is essentially a disease of young trees from seedlings to about 30 years old. Fortunately in Europe the fungus does not attack coast Pseudotsuga taxifolia, but it is so severe on the Rocky Mountain and some of the intermediate forms that it is only a matter of time until they will be eliminated. However, the loss will not be serious because Rocky Mountain Douglas fir grows little or no better than native conifers so that it is not really needed. Individual trees of Rocky Mountain and intermediate Douglas fir have proven highly resistant to the fungus, so, if desired, resistant stocks of both intermountain and Rocky Mountain Douglas fir could be developed.

Contrary to previous reports (Boyce 1939:52; Terrier 1942) that the fungus was not in Switzerland prior to 1941, it was first observed there in the Forest of Tassonayres in September 1932 (Badoux 1932:392) but it was not observed again until 1941. By the spring of 1950, according to Swiss foresters, the fungus was prevalent and was eliminating Rocky Mountain Douglas fir from Swiss forests. This again illustrates the well-known principle that a long period usually elapses after an introduced pathogen appears before it builds up to epidemic proportions.

Rocky Mountain Pseudotsuga taxifolia planted in 1904 in Abbotswood, Forest of Dean, Gloucester, England, had nearly all been killed by Rhabdocline pseudotsugae. Only a few trees remained, characterized by extremely sparse foliage. The stand had been underplanted with Chamaecyparis lawsoniana. Adjoining was a stand of coast P. taxifolia which had made splendid growth and which was completely free from R. pseudotsugae.

Needle Cast of Other Conifers

There was a widespread epidemic of needle cast caused by Lophodermium piceae (abietis) on Picea excelsa in the Austrian Tyrol and adjacent Switzerland during 1949 (Obergmeiner, Willenovsky). The attack was so severe that some trees died. Conditions causing the epidemic were not understood but in certain minds it was in some way associated with the severe drought of that year. The epidemic had subsided in 1950.

Lophodermium macrosporum can be extremely severe on individual spruces but usually it only attacks the odd tree here and there in a stand. It was seen on an occasional tree in the Forst Ebersberger at Anzing near Munich. This forest is mostly pure, even-aged planted Picea excelsa handled on a 100-year rotation.

Spruce Disease

In the Stillewald near Wehl, Netherlands, there was a 20- to 25-year-old plantation of Picea excelsa with the spruce disease or needle cast which is widespread in the Netherlands and adjacent Belgium and which was noticed first in the Netherlands about 1936. The disease affects Picea excelsa, P. sitchensis, and P. orientalis. On P. excelsa the needles are cast slowly over a period of several years but on P. sitchensis they drop quickly. On the P. excelsa examined May 31, 1950, the affected needles were yellowish-green to brown and sometimes mottled. The most heavily infected trees had only the 1949 needles left with the 1950 needles just appearing. The 1949 needles were yellow-green to brown. The less severely affected trees had also the 1948 and older needles left, although usually yellow to somewhat brown in color. On an occasional needle, fructifications of Rhizosphaera kalkhoffi were present but not in sufficient number to account for the condition of the diseased needles. The disease often starts in the upper crown as well as in the lower and when the needles are yellow to brown, the twigs are still green and normal. According to Van Vloten microscopical examination of the needles rarely shows hyphae, and cultures fail to yield anything definite. An aphid, Elatobium (Aphis, Rhopalosithum) abietinum, has been found on the diseased trees and recently it has been rather abundant. To me the disease did not look like one caused by a needle fungus. That aphids can produce such an effect is shown by the extensive dying of tideland P. sitchensis in Oregon in the early twenties. E. abietinum is thought to be of European origin from where it has been introduced into western North America. In 1941 there was an outbreak on P. sitchensis in Oregon and Washington.

The Instituut voor Toegepost Biologisch Onderzoek in de Natuur at Oosterbeek is handling the entomological aspects of the investigation of this spruce disease. According to Directeur Dr. A. D. Voûte, he was convinced at first that the aphid (louse) could not possibly cause the disease on Picea excelsa, but lately the aphids have been found so abundantly in the foliage that it is a distinct possibility that Elatobium abietinum may be responsible.

There seems to be a difference in the disease on Picea sitchensis and on P. excelsa. On the former the disease is caused by Elatobium abietinum. However, on P. excelsa the cause is not yet clear. Went invariably has found hyphae in the affected needles of P. excelsa from which she has regularly isolated a Leptothyrium- or Leptostroma-like fungus. The disease was not seen on P. excelsa where the tree was in its natural habitat.

In the grounds of the Biologisches Centrum, Bockrijk, Belgium, Picea sitchensis was being severely defoliated by the green aphid, Elatobium abietinum. P. excelsa was affected by the spruce disease.

ROOT DISEASES

The two most prevalent root diseases still are those caused by Fomes annosus and Armillaria mellea, although root rots caused by Phytophthora spp. are becoming of some importance, particularly on hardwoods.

Fomes Root and Butt Rot

Fomes annosus (Trametes radiciperda) which causes a widespread root and butt rot on conifers in Europe can be considered as an "indicator" fungus, inasmuch as native conifers on best sites and in natural mixture are but slightly affected.

In the forest Vernand-dessous, Lausanne, Switzerland, the natural forest association from an elevation of 2300 feet and upward is the Fagetum (beech) association in which Abies pectinata occurs abundantly mixed with Fagus sylvatica. Over certain areas this natural association has been replaced with mixed stands of Abies pectinata and Picea excelsa or with pure P. excelsa. There is now a heavy loss from butt rot caused by Fomes annosus in the spruce, the pure stands being most damaged. P. excelsa is below its altitudinal limit. Both the mixed and pure stands containing spruce are to be reconverted to the natural Abies pectinata and Fagus sylvatica mixture with only a little Picea excelsa in order to reduce losses from butt rot in the future.

A 6-year-old plantation of coast Pseudotsuga taxifolia in Zwolse Bos, near Zwolle, Netherlands, on soil formerly occupied by Larix decidua and Fagus sylvatica felled during the last war, was growing well except that about 2 per cent of the trees had recently been killed by Fomes annosus. This was the most severe attack by F. annosus on P. taxifolia seen anywhere. The fungus was fruiting on every dead tree around the root collar, in or just under the duff (May 31, 1950). According to Van Vloten, infection by F. annosus on lateral roots is usually of minor consequence, but when the fungus enters the tap root it progresses to the root collar or just above it, girdling the stem at that point.

An immediately adjacent plantation of Abies grandis of the same age was not making as vigorous growth but it was not attacked by Fomes annosus.

Fomes annosus was prevalent in the pure, even-aged planted stands of Picea excelsa in the Forst Ebersberger at Anzing near Munich, which are handled on a 100-year rotation.

A 45-year-old stand of Larix decidua in Stonehill Wood, Santon Forest, near Santon Downham, England which was found when thinned to have much butt rot caused by Fomes annosus was underplanted in 1944 with several conifers. A small percentage of the Pseudotsuga taxifolia was being killed by F. annosus. Abies nobilis had only an occasional tree killed by the fungus but was growing slowly. A. grandis was growing vigorously and Tsuga heterophylla had made even better growth; neither species was attacked by F. annosus.

Pinus sylvestris and P. nigra var. calabrica (Corsican pine) were planted in 1926 over a large area in Broomhouse Forest, Thetford Chase, England. In 1950 the Corsican pine was taller, with a greater diameter and much better form than the Scotch pine. In 1939 plots of both species were established with heavy, medium, and no thinning. By 1943-1944 dying of the remaining trees began and has been heavy in the heavy- and medium-thinned plots in direct proportion to the degree of thinning, whereas there have been no losses in unthinned plots. Scotch pine has suffered more severely than Corsican pine. The trees have been killed by Fomes annosus. A detailed investigation of the biology of the fungus in this area is being reported by Rishbeth (1949, 1950, 1951).

Shoe String Root Rot

Armillaria mellea, which causes root rot of both conifers and broadleaf trees, can be considered an "indicator fungus," that is, the presence of the fungus as a pathogen indicates a weakened condition of the tree from some previous cause. That drought favors attacks of the fungus is strongly substantiated by outbreaks of this root rot in various parts of Europe in the past several years. This is discussed in the section on Drought.

Phytophthora Root Rot

It has become evident during the past 15 years that root rots associated with Phytophthora spp. are to be found on hardwoods and to a lesser degree on conifers in Great Britain (Day 1938, 1939, 1947, 1948).

Castanea sativa was seen dying presumably from attack by Phytophthora cambivora at Garnons, an estate near Hereford, England. There were large lesions on the butts of the dead and affected trees, with an occasional discoloration on the

bark indicating dried exudate characteristic of the ink disease. Ulmus montana was dying in the same way but the cause was unknown; possibly also Phytophthora.

STEM DISEASES

In temperate climates it is usually stem diseases that are most destructive and this is so in western Europe. Two new diseases have appeared, namely, chestnut blight which threatens the commercial destruction of Castanea sativa, and the dying of sycamore maple caused by an unknown fungus which appears to be potentially dangerous but which has appeared so recently that its possibilities cannot yet be properly evaluated.

Ash Gall and Canker

At Garnons, an estate near Hereford, England, the woods are largely broadleaf trees, Fraxinus excelsior being the most valuable and the favored species. Some of the younger trees were severely affected by a cankerous gall caused by Bacterium savastanoi fraxini (Tubeuf 1936). These could be removed when thinning, leaving sufficient stems for the future, since trees of merchantable size in the woods were canker free. This is a potentially dangerous pathogen for the United States and Canada. B. savastanoi fraxini is not known to be in North America but F. america is susceptible to it as demonstrated by artificial inoculations (Brown 1932). However, F. americana in Europe has not yet been infected, but trees of this species are uncommon there.

In the same stands, several F. excelsior had concentric cankers on the trunk resembling pitted canker of Ulmus americana in the United States caused by Phytophthora inflata (Caroselli and Tucker 1949). P. cambivora is present in these woods on Castanea sativa.

Poplar Canker

At present much work is underway in western Europe to develop varieties of poplar by cross breeding and selection that will be fast growing and disease resistant. There is great need in many European countries for a domestic supply of a soft wood that can be used for matches, veneer, pulp, and similar purposes. Work is being pushed vigorously and an annual poplar conference is held, attended by representatives of various countries. In Germany there is also a society devoted to poplar culture (Hesmer et al. 1949).

Unfortunately, hand in hand with hybrid vigor all too often goes hybrid susceptibility; the usefulness of a hybrid is im-

paired or destroyed by a pathogen harmless to the parents. In Canada and the United States an outstanding example is Septoria musiva which causes a destructive stem canker of several European and American hybrids, among them being Northwest and Saskatchewan poplars whereas on the American parents, balsam poplar (Populus balsamifera) and eastern cottonwood (Populus delloides), the fungus causes a relatively harmless leaf spot. This fungus, if introduced into Europe, could be potentially destructive.

In Europe, poplars are subject to various diseases, the most destructive of them being bacterial canker with which Pseudomonas rimaefaciens is associated. Nectria canker is less prevalent and damaging. Actually it is not yet proven definitely that P. rimaefaciens is the cause of bacterial canker because inoculations with pure cultures of this organism do not produce cankers, whereas inoculations with the ooze or slime which contains three other bacteria not yet named will cause cankering. Later, Nectria frequently becomes associated with bacterial canker.

Bacterial canker is potentially a serious threat to the United States and Canada or to poplars in any other part of the world where the disease is not found. Certain American species are susceptible, as canker was seen on Populus candicans and P. trichocarpa in England.

Extensive work to develop fast growing poplar hybrids is being carried on by Schlenker in the experimental area of the Württembergische Forstliche Versuchsanstalt near Stuttgart.

In the outskirts of Lausanne, Switzerland, near the lake is a row of so-called Canadian poplars, all males, about 40 feet high, with a fine straight stem, and little taper. According to Barbey these trees were obtained from a local nursery in 1943 when they were about 15 feet high and planted out. The tree is a hybrid but nothing more than that is known about it. The growth has been remarkable. The tree will be propagated from cuttings and named Lausanne No. 1. Poplar is valuable in Switzerland for plywood; both cores and faces, and for matches. For the latter purpose wood of Populus tremula is now imported from Poland.

At the École National des Eaux et Forêts, Nancy, M. Lougier, a pathologist, is working largely on poplar disease. M. Rol, Professeur de Pathologie et Botanique in this school, is also much interested in poplars.

Under the direction of Van Vloten there is a large program on selection and hybridization of poplars underway at the Bosbouwproefstation T.N.O., Wageningen, Netherlands. The principal objectives are to develop fast growing poplars that are disease resistant, particularly to canker caused by Pseudomonas rimaefaciens and to leaf rust caused by Melampsora.

Work on poplar canker is carried on at the Phytopathologische Laboratorium "Willie Commelin Scholten," Baarn, Netherlands. Hybrids and selections are being tested for resistance to canker. Inoculations with Pseudomonas rimaefaciens in pure culture fail to reproduce the canker on poplars, but inoculations with the bacterial ooze or slime from infected trees are successful.

At the Forest Research Station, Forestry Commission, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, England, work on the development of fast growing poplars resistant to canker is being carried on by Peace.

Very fine Populus trichocarpa was seen at Garnons, an estate near Hereford, England. The trees were free from canker.

At Ryston Hall, near Downham Market, 30-year-old P. robusta and P. eugenii were growing, the latter having grown much the best. There was no bacterial canker on either variety. In 1935 when this estate was visited, Colonel Pratt, the owner, thought that P. robusta was the best of all the varieties of poplars he was experimenting with but then P. eugenii had not been recognized at Ryston Hall, it was included with P. robusta. P. eugenii at Ryston Hall was the best poplar seen in Europe.

At Lyng Heath, near Santon Downham, England, there was a planting of various poplars, in which P. candicans was highly susceptible and P. trichocarpa susceptible to bacterial canker. These two species are native to North America. Some trees of P. eugenii at this place were severely cankered whereas others mingled with them were canker free, indicating susceptible and highly resistant clones rather than varieties.

Watermark Disease of Willows

This disease of willows, particularly cricket-bat willow (Salix caerulea), which is caused by Bacterium salicis (Day 1924; Metcalfe 1939, 1940) was seen briefly several times in England, the writer having become familiar with it on previous visits. This destructive disease is characterized by a slightly dark, water-soaked discoloration of the normal white wood in the early stages which intensifies to a dark brown or black in the later stages, by premature leaf fall later followed by die-back of branches and finally by death of the tree, although

death may be quite slow. Plantations have been seen with their value completely destroyed, only an occasional tree having escaped dieback of the crown.

Watermark disease is so damaging to willows in Great Britain that it seems reasonable if the pathogen causing it was introduced into North America the destruction would be as bad or even worse.

Dying of Sycamore Maple

The alarming disease of Acer pseudoplatanus (sycamore or sycamore maple) was seen at Wanstead Park where it was first observed by Waller in 1945 at the Claybury Mental Hospital, and at Abney Park Cemetery, Stoke Newington. All these localities are in North London. The disease has been found over an area of about 420 square miles around London and it seems to be still spreading. The fact that the disease has appeared first in a thickly settled metropolitan area strongly suggests that the pathogen causing it has been introduced from elsewhere in the world, possibly North America or Asia.

The symptoms are dark vertical lesions on the trunk or branches resulting from peeling off of the thin outer layer of bark exposing a mass of brownish-black powdery spores (Gregory, Peace and Waller 1950; Anonymous 1950). The lesions are prevalent on smooth-barked stems, but they are unusual on rough-barked stems, although they do occur. Lesions seldom occur on twigs and the disease is rare on trees less than one inch in diameter. The wood beneath the lesions is stained yellow-brown and the staining extends up and down the tree, often far beyond the external limits of the lesions. The fresh brown stain is usually surrounded by a narrow dark-greenish-black zone. Lesions are formed where the staining in the wood reaches the cambium and in this respect the disease resembles canker stain of plane trees (Walter 1946) whereas in the masses of spores produced under the bark it resembles the wilt disease of Diospyros virginiana caused by Cephalosporium diospyri (Crandall and Baker 1950). The lesions enlarge and coalesce until finally the tree is girdled and killed. Staining has been found without lesions, but lesions have never been found without staining.

So many trees have been killed since the disease was first discovered that if infection spreads throughout Great Britain and killing continues at the present rate, the population of sycamore maples would be drastically reduced, or even eliminated. However, outside London the disease seems to be mild.

Elm Disease

The most important fact about the elm disease in western Europe is that it will not completely eliminate elms anywhere provided the trees comprise a mixed population. Consequently, throughout much of Europe, elms in some numbers will persist indefinitely.

In Europe control of this disease caused by Ceratostomella ulmi is based on the development of elms by hybridization and selection that will be resistant to it. This work was first undertaken by the Phytopathologische Laboratorium "Willie Commelin Scholten," Baarn, Netherlands, and this institution is still the leader in the field. According to Went, who is handling the project, it takes 12 to 15 years to test a hybrid properly before it can be distributed to commercial nurserymen for building up a stock for general sale. The most promising tree first developed was elm Christine Buisman, of good form and highly resistant to Ceratostomella ulmi. Unfortunately this selection was so severely attacked by Nectria cinnabarina in the Netherlands that its use had to be abandoned. This elm is still successful in Italy, not having been attacked there by N. cinnabarina.

Ulmus americana is so much more susceptible to Ceratostomella ulmi than any of the European elms, that Went does not use it in any hybridization work.

Only about 3 per cent of the elm population is left in the Netherlands and most of these trees will succumb. The Netherlands was unfortunate in that most of the elms were from a single susceptible clone known as Ulmus hollandica, probably a hybrid between U. campestris and U. montana. Where elm populations are mixed the disease is not so severe. In the center of Amsterdam, elms are still largely undamaged, although around the city many trees have been killed. Some think that this is because the trees in Amsterdam are very old, growing slowly, whereas it is younger, vigorous trees that are most susceptible. Others are not so sure of this.

Up to 1950 about 15 per cent of the elms in Great Britain had been killed by Ceratostomella ulmi throughout the range of the fungus, and replacements were now keeping up with the losses according to Peace. Locally, however, losses have ranged from 1 to 50 per cent. For example the fine elms on both sides of the avenue at Blenheim near Oxford have never been more than 5 per cent infected and only 1 per cent have been killed. The difference between the damage to elms in Great Britain and in Holland is an excellent example of the vastly superior resistance of a mixed population against a pathogen as compared to a single clone.

Examined elms in the Englischer Garten, at Munich on April 15; trees beginning to leaf out, just past the bud swelling stage. As shown by the stumps, hundreds of dead elms have been removed since 1939 when this park was previously examined and a few trees were still being removed. However, there were many elms still left, but the park presents a thin appearance now compared to 1939.

The elm disease is not nearly so destructive in Italy as feared at first. It seems to have markedly slowed down. Younger trees are most commonly killed, older ones being little affected. Many trees are infected, a branch or two is killed, then the fungus seems to die out, the tree making complete recovery. Apparently the fungus entered Italy by natural means, spreading from north to south.

The road from Bologna to Ravenna passed through extensive vineyards in which the grapevines were supported on living Ulmus campestris and occasionally on Populus nigra. The former was particularly desirable because the leaves make fine cattle fodder. The elm disease has killed tremendous numbers of such elms, with severe damage to complete destruction of the vineyards, since Armillaria mellea and Rosellinia necatrix, develop abundantly on the dead elm roots, then attack the roots of the vine. The consequences would have been more serious, except that the wine industry has been in a slump because of the loss of important foreign markets, notably England and Germany. Furthermore satisfactory resistant elms are now available, namely, elm Christine Buisman and another selection made in Italy. Relatively small trees are satisfactory for vineyard use. In Italy, elm Christine Buisman is not affected by Nectria cinnabarina.

Chestnut Blight

Although the destruction of American chestnut (Castanea dentata) in the United States by chestnut blight has been a severe loss, the destruction of European chestnut (C. sativa) in Europe, especially in Italy, would be a catastrophe of a magnitude difficult to comprehend so far-reaching would its ramifications be. In the United States, chestnut as a component of a mixed stand has been replaced by somewhat less valuable oaks, hickories, and other broadleaf trees, whereas in Italy chestnut occurs in pure stands extending the entire length of the country from north to south. It would be naturally replaced by scrub oaks of little or no value. The rural economy of extensive areas in Italy is based on C. sativa,--nuts for food at home and for export, poles for vineyards, wood for various woodworking purposes, and tannin extract. Furthermore, the pure stands of chest-

nut occur so extensively over hilly to mountainous areas that their elimination would result in destructive erosion.

The fungus is behaving just as it did in the United States; it is so highly pathogenic that all trees are killed irrespective of age and size. The fastest growing and most vigorous trees succumb most quickly. In northern Italy where C. sativa is more vigorous and faster growing, infected trees are killed more quickly than in the region of Firenze (Florence) and southward where the species does not grow so well according to Biraghi.

Endothia parasitica Biraghi logically considers was probably introduced into Italy from the United States during World War I, because the first centers of infection were near Genoa and Naples, the principal ports of entry for military supplies, and north of Venice where there was a huge supply depot for the armies. It remained undiscovered until 1938, probably largely because the dead and dying trees were, without examination, attributed to the ink disease caused by Phytophthora cambivora, which had been taking an annual toll of chestnut for many years. Chestnut blight is now widespread (Biraghi 1950).

As the fungus has behaved so far in Italy, control will depend on the development of resistant trees by breeding and selection. At Vallombrosa, where Endothia parasitica has not yet appeared, a chestnut plantation has been established with species, varieties and hybrids from Europe, Asia, and the United States. These trees are to be used for scions, cuttings, and seeds to establish trees elsewhere to test for resistance. In the Fornoli Nursery at Bagni di Lucca there were 46,000 chestnuts of various species, varieties, and races from Europe, the United States and Asia (grown in the United States). They have been established from seeds or imported seedlings, with more to come from the United States. When three years old they will be inoculated through mechanical wounds in an attempt to find resistant trees. Two other nurseries of about the same size have been established elsewhere in Italy.

In the chestnut stands around the village of Cutigliano about 60 kilometres north of Firenze in the lower Appenines, elevation 2400 feet, the blight was first noticed in 1940 but was not definitely determined until 1948. The disease is known to have been there for at least 11 years, because sprouts infected from the trunk are that old. It has probably been present longer. Blight was not discovered promptly because dying was at first attributed to the ink disease by landowners and foresters; no pathologist investigated.

The oldest trees are from 200 to 300 years old and they have all been pollarded repeatedly. Bark on the original trunk

is extremely thick. Infection occurs in the upper part of the tree, that is, in the large sprouts or branches originating where the trunk is cut off, spreads from there into the old trunk, and down the trunk in the thick bark showing no evidence of its presence except that the sprouts along the trunk and finally those at the butt become progressively infected at the base by mycelium from the thick bark. Infected sprouts almost invariably show a noticeable swelling at the base. Heavy losses have occurred in the last three years so that where the infection first appeared all the trees have been removed. The infection is spreading up the slope with not a tree escaping. Nothing but chestnut on the area.

In this section of the Appenines, chestnut appears at about 1500 feet and runs up to 3500 feet or higher. It occurs in pure stands over tremendous areas from the north to the south of Italy. It is vital to much of the rural economy. As one peasant in Cutigliano said, "If the chestnut goes, I will have to be paid to stay up here."

During the long drive from Bologna to Mt. Cimone near Sestola and return, the extensive pure stands of Castanea sativa were impressive. On the return trip a tannin extract plant at Porretta was visited which was completely dependent on chestnut. It supplies extract not only to Italy but to various parts of the world. Employs 150 people in the plant and 350 more make all or most of their livelihood cutting the wood. There are a number of such plants in the Appenines which will close if chestnut is destroyed by blight.

Larch Disease

In the Dovey Valley Forest, near Dolgelly, Wales, was the worst example of the larch disease (Münch 1936; Day 1937) ever seen even in Germany. This disease is characterized by canker and dieback. In Dovey Valley the trees had been planted in 1928. Many of them were dead, the living were only 6 to 15 feet high with small scrawny irregular crowns bedecked with lichens. The stand had never closed so there was a dense ground cover of grass. The plantation was a complete failure and had recently been underplanted with Picea sitchensis.

Fine 100-year-old Larix decidua, without canker caused by Dasyscypha willkommii was seen in the Commune Plieningen, Forst Hohenheim, Hohenheim, Württemberg. This was believed to be of an alpine race from a lower elevation, but actually the provenance was unknown.

Phomopsis Canker of Larch

Phomopsis canker, or more properly speaking bark anthracnose, which has been known for many years on coast Pseudotsuga taxifolia in western Europe and with which the fungus Phomopsis pseudotsugae is associated, has within the past few years become locally prevalent on and damaging to Larix leptolepis.

In a 15-year-old stand of Larix leptolepis in the forest Loener Mark owned by the town of Apeldoorn, Netherlands, Van Vloten (1950) has established 3 series of 36 sample plots each to determine the control and something of the life history of Phomopsis pseudotsugae which is causing considerable damage in Larix leptolepis in the Netherlands (Van Vloten 1948), not by killing the trees but by causing large scars on the lower portion of the bole which later reduces the quality of the lumber.

The experiment was laid out in Latin squares, plots were selected by randomization and the rows of trees for each treatment were selected the same way, except that in each plot there is an unpruned check row in a fixed position. In addition for the first series in each plot there is an unpruned check row selected at random, a row pruned with a club (brushing), a row pruned carefully with a saw, a row pruned by cutting, and an unpruned row but the trees wounded by hammering the stem on 4 different sides and at different levels. Treatments are given every two months for one year for each series, treatments were begun for the first series on November 15, 1948, and all the wounds allowed to become infected naturally if they would. Treatment of the second series began on October 15, 1949. In addition to the unpruned check row in a fixed position in each plot, there is an unpruned check row selected at random, a row pruned with a club, an unpruned row wounded by hammering, an unpruned row with superficial knife wounds on the main stem, and an unpruned row with stem-wounds made by boring a 20 mm. disk out of the bark with a cork borer. In addition part of the wounded trees have been inoculated with a spore suspension of Phomopsis pseudotsugae, and treed in the morning control row of the first series were also bored and some inoculated at the same bimonthly periods.

The results of this experiment so far show that bark killing following infection occurs during the dormant season of the host and that there was a higher incidence of infection in inoculated than in uninoculated wounds indicating that P. pseudotsugae is pathogenic, and not merely a colonizer of bark killed by frost.

In the Coed-Y-Brenin Forest, Hengwirt Beat (Division), elevation 800 feet, near Dolgelly, Wales, a stand of Larix

leptolepis planted in 1929 with 2-year-old nursery stock was brashed (pruned by knocking off the branches with a stick or club) in 1942. Cankers (annual type) were observed on practically every tree within a few months afterwards. Many of the cankers were extremely large, they were on all sides of the trunks, and they were only on the portions of the boles that had been pruned. The injury was not called to Peace's attention until 1948. All lesions were the same age and no new ones have appeared since. About 20 unpruned trees immediately adjacent, and part of the same plantation, developed no cankers. Brashing done in the winter. Day thinks this was caused by frost, but the lesions are exactly like those (although many are larger) with which Phomopsis pseudotsugae is associated in Holland. An adjacent stand of the same age, brashed 12 months earlier (presumably also in the winter), had only a few small cankers.

White Pine Blister Rust

The opportunity to again examine certain plantations of Pinus strobus infected by Cronartium ribicola which were first seen in 1939, demonstrated that if Ribes are not too near or too numerous this tree can be grown successfully despite blister rust. Furthermore, because of the scarcity or complete lack of wild Ribes in many localities, there are numerous sites where this vigorous and aggressive tree could be grown completely or practically free from infection. The value of this tree to Europe is discussed under exotics.

Pinus strobus has been planted limitedly in northern Italy but Cronartium ribicola has never been found on it. This is probably because of lack of Ribes but I did not obtain any definite information about this.

Along the road from Kitzbühel, Austria, to Pass Thurn in the front yard of the Revier Foresters house there was a single large tree of Pinus strobus with several branches killed by blister rust. In the garden just behind the house there was a single bush of Ribes nigrum which was evidently responsible for this infection. About 50 yards up the slope from the garden were 20 large trees 60 years old without any indications of C. ribicola.

Pinus strobus of various ages is still represented in the experimental forest at Grafrath near Munich in spite of steady losses caused by Cronartium ribicola. P. peuce is not resistant to blister rust, probably little if any more resistant in the long run than P. strobus, except that infection occurs and develops more slowly. Of 15 P. peuce about 10 years old examined, 4 had stem cankers which would be fatal.

In the Forst Ebersberger at Anzing near Munich, elevation 1700 feet, from a 45-year-old stand of P. strobus (seen as a 33-year-old stand in 1939) about half the trees were removed then because of blister rust. Since that time (1939) a few trees have been taken out yearly because of blister rust but the operation is satisfactory because the wood commands a higher price than any other in the forest, being 130 per cent more valuable than Scotch pine, and P. strobus grows at least half again as fast. Natural reproduction is excellent and it is planned to continue with this species. No wild Ribes present, all infection coming from gardens of surrounding farms, 2-3 kilometers or more distant. Wooly aphids (Chermes strobi?) prevalent on the trunk of an occasional tree.

Pinus strobus, 17 to 20 years old, had a number of trees with C. ribicola lesions on the main stem, but all the infections were old. The nearest Ribes nigrum was about 1 kilometer distant in a farm garden. An older stand was also seen with scattered stem lesions (Forst Freising, Freising near Munich).

In the communal forest of Zug in Kirchberg near Risch, Switzerland, a 62-year-old stand of Pinus strobus was examined which was seen in 1939 as a 51-year-old stand. This stand has yielded well in spite of Cronartium ribicola, since infected trees removed have been sold regularly at a good profit. Some trees are now infected in the upper bole but it may be 20 years before complete girdling followed by death of the crown, so that the tree must be removed. Natural reproduction excellent and it is planned to continue Pinus strobus on this area, gradually opening up the stand to encourage reproduction.

In the Forst Feldenmoos, property of the village of Boswil, near Muri, elevation 1600 feet, there is a 38- and a 20-year-old stand of Pinus strobus on pure peat, 20 to 40 feet deep covering about 3 to 4 hectares. Originally 10 hectares but a portion was clear cut during the war because the peat was so desperately needed for fuel since Switzerland has no coal. These stands were also examined in 1939. The stands have continued to make excellent growth with only an occasional tree infected with Cronartium ribicola. The nearest Ribes are in the village of Boswil about 2 kilometers distant. The white pine is screened by the surrounding forest of Abies pectinata, Picea excelsa, and Fagus sylvatica.

Pinus strobus, 80 years old, mixed with Picea excelsa, Larix decidua, Pinus sylvestris, and other conifers had made excellent growth in the Forst Rapperswil, Rapperswil, although an occasional tree had been taken out because it was infected by Cronartium ribicola. However, all such trees had been sold at a high profit, since Pinus strobus commands a price four

times as great as Picea excelsa. In this stand there was abundant natural reproduction of Pinus strobus in the openings.

In the same forest where Pinus strobus mixed with Fagus sylvatica makes up a 90-year-old stand the pine has made splendid growth, having pruned well so that the trees have a long clear-length. Only an occasional tree is infected by Cronartium ribicola. The site, on an old weathered moraine, is extremely good.

Pinus strobus, 95 years old, in mixture with Picea excelsa, Abies pectinata, and Fagus sylvatica had grown extremely well in the Forst Zofingen, Zofingen, Switzerland. There was excellent natural reproduction nearby of P. strobus 12 to 15 feet high which was being attacked by Cronartium ribicola. Siebenmann thinks that possibly 10 per cent of the white pine reproduction will escape C. ribicola. If so this will be sufficient to be profitable.

A 60 to 70-year-old stand of Pinus strobus in the Forst Langenthal, Langenthal, Switzerland was free from Cronartium ribicola because infected trees had been removed as soon as found and at a profit. A 50 to 60-year-old stand was the same. According to Meyer in the younger age classes, infection by Cronartium ribicola is worse on planted P. strobus than on naturally reproduced.

A plantation of Pinus strobus, sapling size, in Willems Bos, the property of Van Vloten, near Nunspeet, Netherlands, had considerable infection by Cronartium ribicola which had all occurred in one year, apparently 1946, although a careful tally of canker distribution was not made to determine the year exactly. Ribes nigrum in a garden was less than a kilometer distant. It was surprising not to find more infection in this plantation and particularly noteworthy that infections were confined to one year instead of occurring almost every year as usually occurs from nearby R. nigrum.

Mistletoe

In western Europe there is only one important mistletoe, namely Viscum album. It does not occur in the northern part of that continent just as the American mistletoes, Phoradendron spp. are not found in Canada and the northern United States. In France, V. album is said to be more prevalent on trees on poor sites. V. album is especially severe on poplars although in the genus there is evidence of both individual and varietal resistance to it. French authorities

consider that Populus nigra and presumably its hybrids are less susceptible than other poplars. Various American hardwoods growing in Europe have been attacked. By far the most damaging infection seen on any tree, European or American, was on a few Robinia pseudoacacia in France which were almost dead from the effects of an extraordinarily heavy attack.

Consequently Viscum album can be considered potentially dangerous to the United States. If somehow introduced to this country it would probably be thoroughly established and widespread when it was finally discovered, because it would likely be some years before it was recognized as not being a native Phoradendron.

A single tree of Juglans nigra, 130 years old, 4 feet in diameter breast high, and 100 feet tall had a few moderate sized plants of Viscum album on the branches. A very large Acer saccharum of the same age had 5 huge V. album plants on the branches together with some smaller ones (Exotischer Garten Hohenheim, Hohenheim, Württemberg, Germany.)

Viscum album was seen occasionally on Pinus sylvestris in stands along the Autobahn between Stuttgart and Heidelberg, Germany. One tree 16 inches diameter breast high was noticed near Heidelberg with a large plant of this mistletoe on the trunk 15 feet above ground level.

Viscum album was prevalent on various hardwoods and fruit trees along most of the route from Chartres to Orlean, Vierzon, Bourges and Moulin in France. Near Moulin there were extensive stands of oak, probably Quercus sessiliflora, but no mistletoe was noticed on the trees.

Along the route from Lausanne, Switzerland to St. Dizier, France, via Vallorbe, Switzerland, and Pontarlier, Besancon, Langres, and Chaumont, France, both roadside and plantation trees of Populus were extremely heavily infected with Viscum album, although individual trees and entire plantations here and there were not attacked, suggesting both individual and varietal resistance to the parasite. Between Besancon and Gray there were a few Robinia pseudoacacia with so many and such large plants of V. album that the trees were moribund. This was the most severe injury by mistletoe ever seen in Europe and is comparable to the effect of Phoradendron flavescens on certain hardwoods in Texas and adjacent Oklahoma.

PATHOGENS DANGEROUS TO NORTH AMERICA

With the exception of the spruce disease, the dying of sycamore maple, and chestnut blight all the pathogenic diseases

encountered this time had been seen previously. It is fortuitous that some of them have not yet reached the United States and Canada because they were prevalent in Europe before these two countries enacted adequate quarantine laws.

The most dangerous disease seen was bacterial canker of poplar. Certain American species, namely Populus trichocarpa and P. candicans, are susceptible to it and undoubtedly others are also. Particularly important is the reaction of P. tremuloides which should be determined. Although poplars in the United States and Canada do not have the high relative value that they have in Europe, yet they are an asset of some importance here. Their future value may be greater.

Another serious bacterial disorder is the watermark disease of willows so prevalent and destructive in Great Britain. Although no American willows were seen that had been exposed to the bacterium, its potentialities for damage seem high. Ash gall and canker is still another bacterial disease that could be destructive in the United States, since Fraxinus americana has proven susceptible to it when inoculated with the causal bacterium.

The dying of sycamore maple (Acer pseudoplatanus) is caused by a fungus as yet undescribed and of unknown origin, but seemingly introduced. It could be American or Asiatic. An examination of the disease and accounts of it from others indicate that, although damaging, it is not completely destructive and it progresses rather slowly so that the disease is one that can be tolerated. Although predictions as to the behavior of a fungus in a new environment and on new hosts are hazardous, if this fungus was introduced into North America it would probably be damaging but not catastrophical. Of course the pathogen may be from this continent; if so it is no threat to us.

The spruce disease of Picea excelsa is possibly caused by Elatobium abietinum which has already been introduced into western North America where it attacks P. sitchensis. The disease was not seen in stands within the natural range of P. excelsa. Until the exact cause of this disease is known it must be regarded as a potential threat, particularly to spruces in the eastern United States and Canada including P. excelsa which has been planted to some extent in the Northeast.

Dendroctonus micans is so severe on Picea sitchensis that it is likely that in western Europe plantations cannot attain an age of much over 50 years before they

are destroyed. Such behavior suggests that this bark beetle might be extremely destructive to P. sitchensis or to eastern spruces if it reached this country.

The common European mistletoe, Viscum album, is a danger to the forests of this country. Although it is unlikely that it will be introduced, if it should be almost surely it would be well established and widespread before it was recognized since for some time it would simply pass as one of our native species. This mistletoe has been found on various North American broadleaf trees in Europe. The most severe attack seen was on Robinia pseudoacacia in France where the few trees examined were moribund from the heavy infection. In addition, races of Viscum album attack Pinus sylvestris, Abies pectinata and several other conifers in Europe, so that in North America the parasite would have a wide possible host range.

Although there are many arboreta throughout western Europe in which specimen trees or groups of the most important North American trees, particularly conifers, may be found, only a few species have been planted extensively enough and long enough as forest trees so that they have had adequate exposure to European pathogens. Pinus strobus, Pseudotsuga taxifolia, Quercus borealis, and Robinia pseudoacacia are in this category. Picea sitchensis has had a fairly good test, while Abies grandis Pinus contorta and P. radiata have had limited exposure. Other North American trees are either inadequately or practically not at all represented in Europe for trap plantation purposes. This is particularly true of the broadleaf trees and eastern conifers. In cooperation with European authorities, trap plantations of the more important North American trees should be established throughout Europe; in this way dangerous pathogens could be recognized and understood before they reached our country.

Particularly important is an adequate test of Pinus ponderosa, P. contorta, P. resinosa and certain other of our hard pines against Peridermium pini. This rust fungus causes a serious disease of Pinus sylvestris known as dry top, i.e., death of the leader or a large part of the upper bole. Mature trees as well as younger ones are affected and as high as 90 per cent of the trees in a pure stand have been stag-headed. Furthermore, infection occurs directly from pine to pine by means of aeciospores so that the possible damage from this rust is much greater and control more difficult than for most of the Cronartiums on pines. Although P. contorta grows well in Italy and P. ponderosa should thrive there, yet no Peridermium pini occurs in that country so that plantations to test the reaction of American pines to it would have to be established in Germany or Scandinavia where the rust is prevalent.

Although no new pathogens which appear to be extremely dangerous to this country have appeared in Europe in the past decade, some of those of long standing have a high destructive potential in relation to our trees. Since quarantines, although valuable, in the long view must be considered as measures of delay rather than exclusion, since sooner or later a pathogen is likely to slip by a quarantine, i.e., Ceratostomella ulmi, therefore it is important to have plantations of the more valuable North American species established throughout western Europe to test the reaction of our trees to well known European pathogens and to pick up new pathogens that may appear there. All information that can be had on the effect of foreign pathogens on our trees in advance of the introduction of these pathogens into North America will be invaluable for control work when necessity arises.

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